MODERN BUSINESS

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Modern Business

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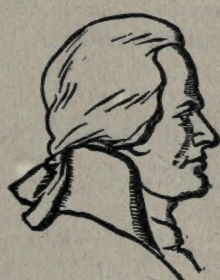

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Modern Business

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Modern business

COST FINDING

BY

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MODERN BUSINESS

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PREFACE

It has been the aim of the author in writing this book to discuss in a direct and simple manner the fundamental principles that underlie all cost-finding systems. Abstruse and abstract arguments have been avoided and an effort has been made to make the work of practical use. Commercial data, diagrams and typical documents used in cost finding have been inserted only where needed to illustrate the discussion, and no attempt has been made to present complete cost systems, as is often done in treatises of this kind. Industrial conditions vary widely, and it is believed that if the fundamental principles of cost finding are thoroly understood and the peculiar conditions of the particular problem in hand are carefully studied, the making of blanks and forms should be a minor difficulty.

Care has been taken, also, to point out as far as possible the limitations of the theories and methods that have been discussed. Cost finding, at best, is a complex matter and is far from being an accurate science. The successful choice of a cost-finding system that will be suitable for a given set of conditions depends to a large degree on a knowledge of the limitations of the methods to be employed. In all prob-

ability more systems fail because of a lack of knowledge of limitations on the part of those instituting or operating such systems, than for any other single reason.

The author has consulted freely the works of other writers in this field, and so far as possible such aid has been acknowledged in the Text. Grateful acknowledgment is here made, however, for such help as has not been specifically mentioned. The writer is particularly indebted to the writings of Mr. A. Hamilton Church and Mr. Stirling Bunnell, from which he has drawn much helpful assistance. Any suggestions or criticisms that will assist in improving the Text will be gratefully received.

DEXTER S. KIMBALL.

Ithaca, N. Y.,

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COST FINDING

CHAPTER I

THE IMPORTANCE OF COST FINDING

1. *Few men understand cost finding.*—No part of modern industrial organization is of greater importance than that of cost accounting. At the same time there is perhaps no part regarding which so little is generally known. In the great majority of industrial establishments the art of cost finding is still in a crude and undeveloped stage so far at least as individual detail costs are concerned. This is particularly true of the small shop, or the shop which has grown up around a pushing and skilled mechanic, whose knowledge of the practical side of his art is great, but who neither knows nor appreciates the need of scanning his detail costs more closely as his business becomes more and more complex. According to Bradstreet's,[1] four-fifths of the industrial failures in this country are the result of faults, or incompetence of one kind or another, on the part of those who fail, and ignorance of the true cost of production is, without doubt, one of the most common of the shortcomings.

[1] *Bradstreet's,* Jan. 21, 1911, and Jan. 27, 1912.

2. *Purpose of cost records.*—Cost finding is a complex matter, at best, and as industries grow to great proportions this complexity is increased in like ratio. The methods and approximation which may be ample for a small business which is wholly under the eye of the superintendent, cannot be relied upon when the plant becomes so large that personal observation is insufficient; system of some sort must be resorted to. Furthermore, the demands of modern industry require vastly more of a cost system than was deemed necessary a short time ago. In many shops, today, the cost system is considered satisfactory if it simply shows the cost of producing the several items manufactured. But the modern conception of a cost-finding system is far broader. Such a system must not only show costs as such, but must show them in such a form that deductions may be drawn as to the *reasons* for them and the possibilities of reducing them. Results must be so reliable that the costs may be used as a basis for predicting future shop operations and costs. A cost-keeping system that simply records costs for the purpose of fixing sales prices has accomplished only a small part of its mission, and every day shows an increasing tendency to demand of the cost-keeping department that it furnish each activity of the enterprise such financial statements as will act as safeguards in the conduct of its individual functions.

A good cost system properly conducted should enable the manager to prepare estimates with some assurance that a profit will be made if the work is under-

taken, and at the same time should enable him to meet competition on an intelligent basis. It should tell him what lines of product pay and what do not. It should enable him to gauge the efficiency of each department and to trace the reasons for inefficiency if such exist. It should be his guide and counselor in directing the activities of his business. On the other hand, care must be exercised that the system installed is not too complex and that the cost of securing the detailed information is not greater than the gain that may result from its possession. Complexity is no assurance of accuracy. And an over-complex system may not only secure results that are useless but may be an actual hindrance to rapid production, thru too much "red tape."

3. *Trained men required.*—As will be seen later, there is almost no end to the detail to which a cost-finding system may be carried. In the hands of an overzealous accountant or one whose range of vision is narrowed by the intricacies of his calling, an over-elaborate system may be installed that not only will result in financial loss, thru the expense of operating the cost-finding machinery, but also as has been noted, may act as a clog on the actual machinery of production. The introduction of a satisfactory cost system requires, therefore, more than a knowledge of cost-finding methods. It requires an intimate knowledge of the industry itself, of the particular institution, and a keen discrimination regarding the detail to which the cost finding is to be carried. Very rough detail

costs may be satisfactory in some lines while very refined cost statements may be essential in others. Even in the same establishment the same degree of detail accuracy is not necessary in all lines, and a skilled chief cost finder can save large sums in the operation of his system by a careful observance of the relative importance of different lines of product.

For these reasons the installation of a cost-finding system should not, usually, be left wholly to the general accountant. It is true, of course, that the cost books, for best results, should be properly merged into the general accounts and should fit into the broad plan of the general scheme of accounting. But the cost-finding methods that will produce best results will, in general, be the result of the joint labors of the skilled accountant and the manufacturing expert. A careful distinction should be made between principles and the details to which the application of these principles may be carried. The principles of cost accounting are definite and permanent, but the degree of detail to which it is desirable to carry their application can be fixed only by some one well-versed in the details of manufacturing, who knows just what results are desirable and what results are useless.

Even the manufacturing expert and the skilled accountant can obtain much help by considering the requirements of other departments. Thus the clerical work and accuracy of cost finding are greatly aided by a proper system of nomenclature and identification. Such matters involve the work of the design-

ing department, and a system in the drafting room laid out with reference to the cost-finding system is an invaluable aid.

4. *Each business requires individual study.*—It is obvious also that no particular cost-finding system will apply to all forms of industry, since industries vary so widely not only as regards the character of the work they are conducting but also as regards the manner of their organization. The information that the cost system should gather, and the manner in which this information should be presented, will also vary widely in different enterprises. The cards and forms which are admirable for one kind of work are useless, therefore, in others. The general underlying principles of cost finding are, however, universally applicable and if the principles are clearly understood there is seldom any difficulty in developing cards and forms suitable to the work in hand. Many good suggestions can be obtained by a study of the blanks and forms found in current practice, but the presentation of too great a variety of such documents tends to obscure basic theory. This book, therefore, deals with general principles only, and only such blanks and forms have been inserted as are necessary to illustrate these principles.

5. *Importance to whole industries.*—While accurate costs are of great importance to the individual institution, they are of no less importance to the industry as a whole. The manufacturer who obtains contracts by underbidding his competitors, with a price on which

he will lose money, not only ruins his own business but destroys that of his competitors. This form of competition is the most dangerous and the most greatly to be feared, since it rests, in most cases, on ignorance. It is little consolation to the manager whose costs are accurately obtained to see such competitors go into bankruptcy; for, as fast as they disappear, others equally ignorant take their place. Yet this state of affairs is far too common.

In a competition that came under the writer's observation recently, the highest bid was nearly fifty per cent higher than the lowest. After making allowance that the lowest bid may contemplate scant fulfilment of the specifications, and that the highest may be simply hopeful advertising, the only reasonable explanation that can be offered for such a great range is ignorance of basic cost-finding principles. Any one who has had experience in opening competitive bids will testify to the wide divergence in prices that usually appears in such competition. It is for reasons such as these that the intelligent manufacturer often finds himself confronted with the fact that his bid must be based on market prices and not on his costs. It is no use to bid higher, unless he has a superior article the merit of which commands the trade irrespective of price. On standard articles the "trade will not stand" the higher price. Even here his only hope of succeeding is to know the true cost and to try, by better manufacturing, to so reduce it as to leave him a margin of profit.

Furthermore, it is only too often held that cost-finding methods are secret matters that should be kept from the eyes of competitors. No doubt it may be good business policy to keep actual costs secret, but the widest publicity should be given to cost-finding methods if for no other reason than that of educating one's competitor in such methods as shall tend to fair competition. This is now clearly recognized in many fields of industry. The National Machine Tool Builders' Association recognized this important principle some years ago and took active steps toward uniform methods. It would pay all competing industries to do likewise and to publish freely the correct methods by which the costs of their products are obtained. The manager who offered to send his expert accountant, at his own expense, to teach competitors his system of cost finding was a man of keen business ability and not simply a philanthropist.

6. *Inadequacy of crude methods.*—It is true, of course, that many enterprises make money with the crudest kind of cost-keeping systems, but where such is the case there are always advantageous conditions the continued existence of which cannot elsewhere be assumed. Many plants, also, make money in spite of antiquated machinery and methods, either because of local advantages or because lack of competition allows large profits. Strong leadership may often compensate for material disadvantages. But such favoring conditions may not be so easy to maintain in the future. As industry grows, competition becomes ever

keener in all branches of life, with the consequent requirement of a more exact knowledge of the details of business. And as any enterprise increases in size the methods based merely on personal observation become increasingly inadequate.

A grocer who fixed the selling price of sugar with reference to that of his competitor, and not with reference to what it had cost him, would be considered as having adopted a decidedly unsafe policy. And yet this is a common method of fixing prices in the manufacturing field. Many manufacturers often persist in paying dividends out of capital simply because they do not know what their selling price ought to be but have fixed it either by that of some competitor or by some rule of thumb. Enterprises of this kind collapse like houses of cards when dull times arrive, and constitute, no doubt, a large proportion of the four-fifths of the failures which are due to personal incompetence. Accurate knowledge of the cost of production is an absolute necessity and the detail in which it is required to know these costs grows daily with the growth of enterprises, the increase in competition and the development of new methods of management.

REVIEW

What reasons would influence you to establish a cost-finding system in your own business?

What effect upon your decision would the following factors have: size and character of the business; expense of installation and operations?

If the selling prices of the product that you are manufacturing

are regulated primarily by competition, would you consider it advisable to instal a cost system? Why?

What benefits would you, as a manufacturer, derive from the adoption of a uniform system of cost finding in the industry, and would they lead you to cooperate freely in the plan?

CHAPTER II

PROBLEMS OF COST FINDING

1. *Bookkeeping, accounting and cost finding.*—A clear conception should be had of the relation between accounting, bookkeeping and cost finding. Accounting is the science of recording transactions in terms of money, which is the measure of all commercial and productive performances. Where properly conceived it is of much wider scope than bookkeeping, with which it is often considered identical. Bookkeeping is, more strictly speaking, the clerical work of recording transactions, but accounting goes further and deduces financial statements that may serve as safe guides for the conduct of the business. Almost any one can introduce a system of bookkeeping that will show the balances and general results of the business, but to lay out an accounting system that will anticipate future performances and guide the manager safely where the details are so great as to be beyond his grasp, is a different matter.

Cost finding is that part of general accounting which deals with the finding of the detail costs which make up the general or summarized costs. It is, therefore, closely connected with shop processes and shop management, and the cost keeper usually is

placed directly under the manufacturing superintendent. Cost finding can be carried on with little reference to the general accounts, and this practice is not uncommon. The general books should always show accurately the totals of all labor and material that have been purchased for any and all purposes, and also all receipts for sales, without regard to the details as to how these expenditures and receipts were brought about. It is clear also that the summaries, as shown by the general accounts, can be accurately determined, since these summaries can be based upon purchase orders, payrolls, bills of sale and similar documents. It is clear, also, that these general summaries will show whether the business is prospering or not and will show also whether the prices asked are, in general, sufficiently high to cover all expenditures and insure a profit. However, if it is desired to know something regarding the detailed cost of some particular job or article this information can be obtained only by opening a special ledger account with it. In small enterprises this is sometimes done, but in undertakings of any magnitude such a procedure would lead to undesirable complexity and extent in the general accounts. Cost accounts are therefore usually conducted as an independent investigation, the cost summaries not necessarily being merged into the general accounts.

2. *Cost accounts a branch of general accounts.*—For best results, however, the cost accounts should be treated as a branch of the general accounts and the

cost summaries should be merged into the general accounts. It will be seen from the following discussion that it is difficult to keep absolutely accurate cost accounts, and that the cost summaries do not always agree with the corresponding totals of the general accounts. These facts are sometimes used as arguments against cost-finding systems as a means of setting sales prices but this argument is not valid. Any cost-finding system worth considering should give results that can be reconciled with the totals of the general account with sufficient accuracy, or the difference should be explainable on some other ground than that of inaccuracies in the cost-finding methods. General accounting is obviously necessary to secure accurate general summaries, and cost accounts are necessary to show the details of each summary where such details are needed. The two systems should, therefore, be related parts of one general scheme of accounting. Evidently the installation of a cost-finding system should be the joint work of the skilled accountant and the manufacturing expert.

General accounting must be conducted in practically every business, but cost finding, in a detailed sense, may or may not be necessary, tho, as before stated, it is often badly needed in many places where it is not considered necessary.

3. *Divisions of productive industry.*—To illustrate these relations, consider the case of a farmer who is producing wheat, barley, oats, cattle, sheep, poultry, eggs and, in addition, operates a small truck garden

where he grows a number of varieties of vegetables. Under the old methods which were practised a few years ago, his farm and the labors of his family and himself would perhaps supply him with practically every need. Accounting was hardly needed, since he could see the state of his resources. But under present conditions he must buy many of his necessities; if he hires helpers they must be paid in money, which can be obtained only by selling the products of his farm. He must, therefore, add to his labors as a producer both those of a buyer and those of a seller. It now becomes increasingly difficult for him to carry the records of his many transactions in his head and he must proceed to write them down in some orderly and systematic manner, thus adding accounting to his required duties. The growth of the farmer's activities also brings about added financial responsibilities to which special attention must be devoted. Thus, he may be compelled periodically to borrow money in order to harvest his crop promptly or to perform a large amount of plowing in a short time. The essential features of productive industry, in short, are buying, producing, financing, transporting to market, selling and accounting. In most cases buying is considered as a part of producing, and transportation to market as a part of selling, so the four divisions of production are then, manufacturing or growing, financing, selling and accounting.

If, now, this farmer is prosperous, he may keep only such accounts as deal with his receipts and dis-

bursements. He will record all purchases for fertilizer, machinery, insurance, repairs, drain tile, etc., and will also record all money received from sales of produce. The balances from these general accounts will always inform him how he stands, as a whole, with his business world.

4. *When cost records become necessary.*—But suppose he is not prospering, or suppose he wishes to know what lines of effort are giving him his highest returns. He then must begin to keep an individual account with each activity into which he wishes to inquire. Many farmers of the better informed class now keep records of each cow or even of each hen in making economic studies of this kind. Almost instantly, however, the farmer under discussion finds that these individual cost accounts are decidedly different in character from the general accounts he has been keeping. The general accounts were accurate and he could account fully for all the items entering therein. But these individual accounts contain items that are not definite.

For instance, the same man that feeds the cattle helps to market the eggs. The insurance on the barn is chargeable partly to one activity and partly to another. Some of the general supplies which he has purchased spoil on his hands; other supplies are not fully accounted for, because of waste, or failure to obtain accurate account of their distribution. Some of the supplies that he has purchased are used in so many different activities that he finds it difficult to

apportion them with any semblance of accuracy. He also finds it practically impossible accurately to apportion his labors in his truck garden over the many products grown therein. He must, therefore, be content with approximation to a certain extent in making up these accounts. The greater the detail into which he wishes to go the more difficult it becomes to segregate the costs of the several lines of effort with which he is concerned. It is clear, however, that by making intelligent approximations he can separate the cost of his several activities so as to obtain a fairly clear view of their relative values, and if these approximations are skilfully made the summaries of his cost accounts should coincide fairly well with those of his general accounts. This particular difference between general accounts and cost accounts should be carefully noted. The general accounts must be accurate and must balance; cost accounts are seldom exact and it is often difficult to make their summarized totals agree closely with those of corresponding general accounts which are based on much more accurate statements.

If this farmer is very progressive or has a speculative mind, he may record the relative costs of producing different products under varying conditions, with a view to guiding himself in future work. That is to say, he begins to collect statistical data based on his cost accounting which will enable him to predict, in some degree at least, the results of future efforts. This was once a secondary feature of cost accounting, but it now bids fair to be as important as the original

function performed by cost-finding methods, namely, that of finding out what the actual costs of production are.

The general principles underlying the farmer's cost records are applicable to all branches of productive industry tho the methods of applying them may vary widely. The illustration of the farmer was purposely selected to show that these principles apply even to handicraft production of the simplest kind. A brief consideration of any of the handicraft callings, particularly as they grow in magnitude, will disclose analogous conditions, and will assist in making clearer the increasing complexity of these principles as they appear in large modern factories. It is in the highly organized modern factory that the greatest complexity is met; the following discussion is therefore directed largely to factory methods. The general application, however, should not be lost sight of.

5. *Application to manufacturing plants.*—One of the most marked and important characteristics of modern industry is the tremendously extended use of the principle of division of labor. While this principle is inherent in the formation of civilized society and has been used by mankind from the beginning, the modern industrial era has extended its use in a most remarkable degree. The installation of highly developed and specialized machinery has aided materially in furthering the use of this principle. The production of the smallest article may be the work of many hands. One man may plan or design it, another may make

tools for its production, many others may work on individual operations, not even knowing what sort of article the several parts are intended for; while others, who may not have seen a single part manufactured, may assemble the completed product. The cost of any manufactured article, therefore, may be made up of the cost of small portions of the labor of many men, some of whom may work directly upon the article and some of whom may work only indirectly upon it. As in the case of the farmer, it may not be easy to compute just what the exact total cost of the final product may be.

A diagrammatic outline of the essential factors in any productive enterprise is shown in Figure 1 (page 18). No matter how complex the ownership of a plant may be, it can be, and usually is, reduced to a board of directors or some similar group which represents the owning body, and dictates the general policy of the enterprise. These directors in turn may be represented by the president or general manager who is in actual charge of the plant. They may also elect such officers as the secretary and the treasurer to serve as independent checks on the operation of the business. Under the president are the four main branches or departments of operation already noted, namely, producing, selling, financing and accounting. If the plant is owned by partners or by an individual the organization is, of course, simplified, and where the plant is small, one individual may perform several of the foregoing functions. The general idea, however, of the

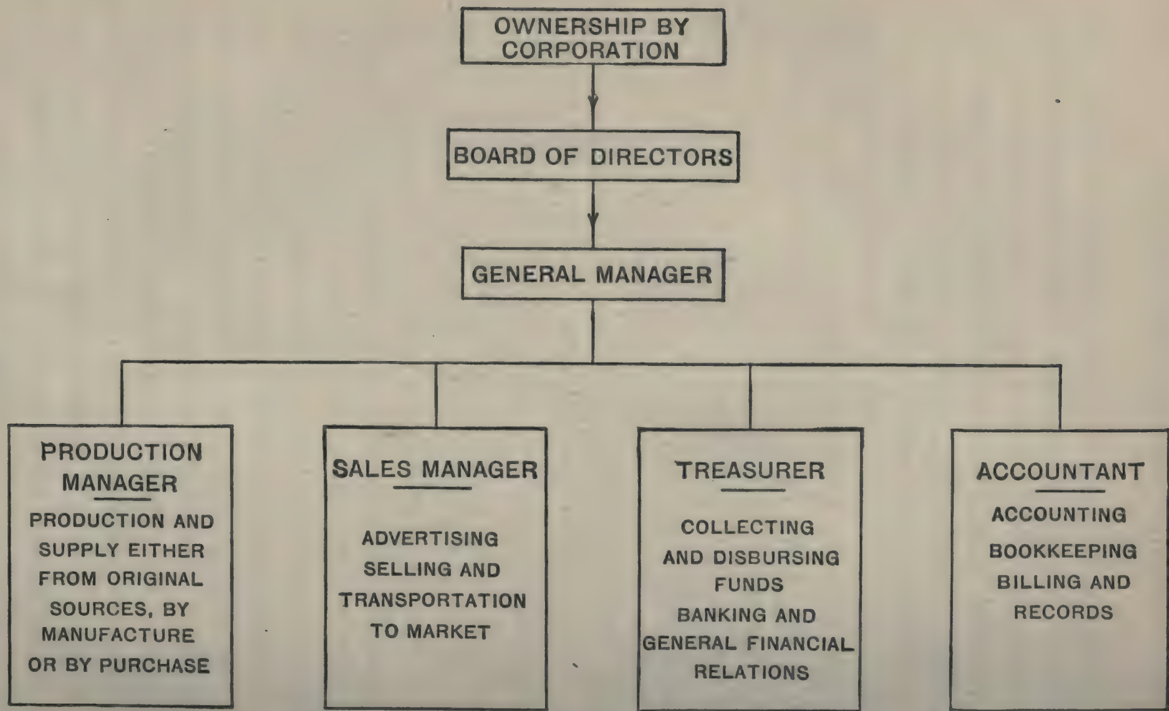

FIGURE 1—THE FOUR FUNDAMENTAL BRANCHES OF AN ENTERPRISE

four main branches should not be lost sight of, no matter how much the detail arrangements of the administration may vary. For instance, in some cases the engineering department is so important as to be placed directly under the general manager, but this is purely an administrative matter and does not affect the principles presented, the engineering department being strictly a branch of the production department. Such an arrangement is, in fact, another manifestation of the advantage of division of labor. Formerly all engineering planning was done in the shop as the work progressed, and often by haphazard methods. Experience has shown that better and more economical results are obtained when this work of planning is in the hands of specialists. Similar remarks would apply to industries where other kinds of highly trained specialists, such as chemists, for example, are employed.

6. *Departments not always fully developed.*—It may be noted that the degree to which some of these departments may be developed in any one industry or enterprise may vary widely with conditions. Some concerns have only very rudimentary sales departments, depending on other organizations to dispose of their product. In other cases the sales organization may be highly developed and it is not uncommon that the cost of marketing a commodity is equal to, or greater than, the actual cost of production. Other enterprises, again, may do little or no purchasing of materials except for machinery and repairs, having acquired once for all such natural sources

of supply as are necessary for their purpose. Still other enterprises do no producing, in a strict sense, the purchasing department taking the place of the production department which is so prominent a feature of other industries. Thus a mercantile concern simply buys finished or marketable goods and sells them again. The general principles involving all four functions should not be forgotten, however, and accounting, as has already been noted, must always be carried on, whether the enterprise in question does buying, producing, or selling, or all three combined.

7. *Departmentization.*—As a factory grows in size, or as the scope of the work broadens, the economic advantage of the use of division of labor naturally brings about departmentization. Departmentization is also desirable from the standpoint of administration—and the entire problem of cost finding is closely connected with the problems of organization. A diagrammatic outline of the several departments of a typical manufacturing enterprise, showing the relative positions of the several departments, from an administrative standpoint, is shown in Figure 2 (page 21). The four main divisions, producing, selling, financing and accounting are functionalized under the general manager, in the care of the sales manager, the factory manager, the treasurer and the accountant, or controller. Under the factory manager is organized the production department with its many sub-departments. Some of these sub-departments are functionalized directly under the factory manager while others

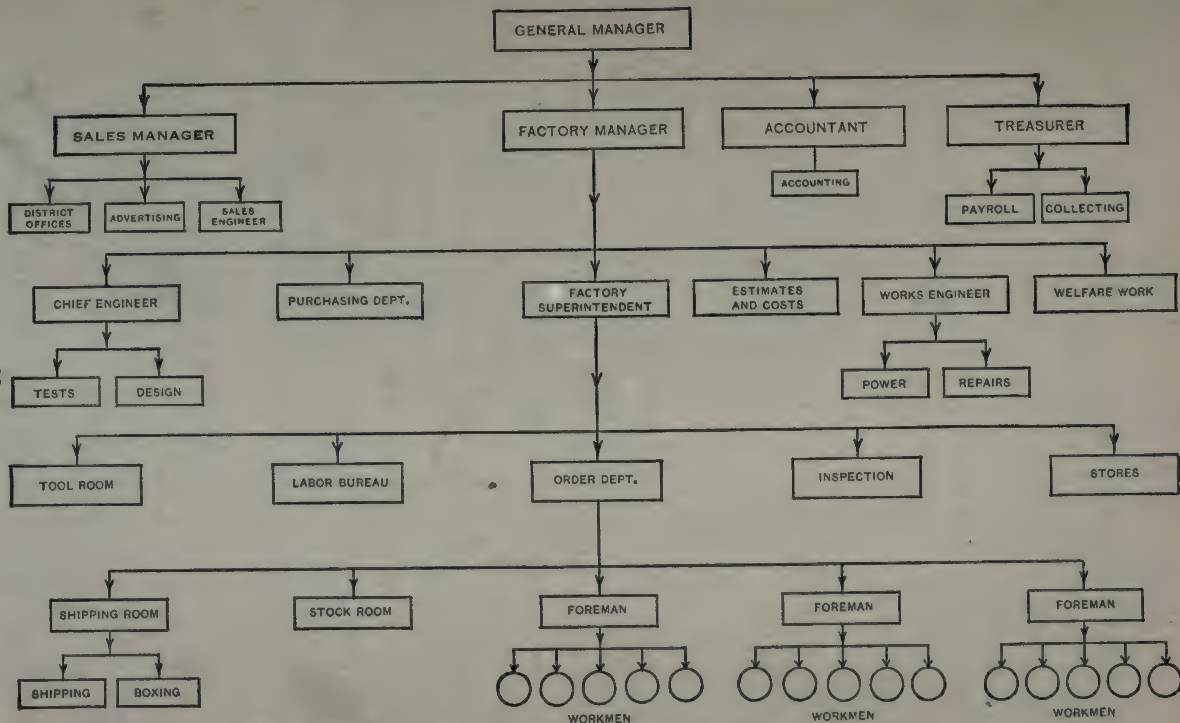

FIGURE 2—DIAGRAMMATIC OUTLINE OF MANUFACTURING

are placed under the factory superintendent. The arrangement shown is suggestive only, tho it illustrates a somewhat common arrangement of the several departments.

It will be noted that the duties and functions of the men in the various departments are often decidedly different in character. Thus, there is little in common between the work of the shipping room and that of the labor bureau. It will be noted also that many of the men employed do not work directly upon the product. The engineer in charge of the power house, for example, does no work on the product itself and the power which his department produces may or may not be used on all products. The engineering department may make designs for some jobs,[1] while for others it may do nothing. Crane men, office clerks, errand boys, etc., are employed on work that is general rather than specific, and it is difficult to apportion accurately the amount of time that they spend on each piece of the factory product. The proportion of men that may be thus indirectly employed may be very large, and the modern tendency in all mass production is to increase this proportion rather than to diminish it.

This general tendency toward departmentization and division of labor should be carefully noted by the student of cost systems. Certain fundamental principles in modern manufacturing methods work irre-

[1] The author feels that no apology is needed for the use of this homely but expressive term. There is no other word that fully takes its place.

sistibly to increase this tendency. The four primary divisions of a business, namely, producing, selling, financing and accounting, are functional divisions. That is, the division is based on the *character* of the work performed. Again, under the factory manager (see Figure 2) are found several departments, the functions of which are different. The designing of the product is separated from the actual construction, and the purchasing is set aside as the separate function of a specialist. The separation of the planning of the work from its construction should be especially noted. Until quite recently this principle had not gone far beyond the separation of the engineering and the construction department. But recent developments tend to carry this principle of the separation of the planning and the constructive function much farther down into the shop itself. Scientific management, so-called, is based intrinsically on a rearrangement of the work of foremen and workmen, according to the *functions* to be performed, rather than according to the principles underlying the enforcement of discipline, as heretofore. Whether functional foremanship, as contemplated by scientific management, becomes a large factor in our industrial organization, remains to be seen; but the drift is toward further specialization of this order. Such a separation of functions always increases the amount of general, or indirect, labor and decreases the amount of specific, or direct, labor that is put upon the product. As the tendency grows, the necessity of more accurate dis-

tribution of cost increases while, at the same time, the difficulties in the way of accurate allocation of cost elements also become greater; all of which points to the need for more refined cost-finding methods as competition becomes keener.

REVIEW

Differentiate bookkeeping, accounting and cost finding.

In your opinion is it advisable to provide for a control of the cost books by means of accounts in the general books?

How would you prepare for your own use charts that will show:

(a) the four fundamental branches of a business enterprise?

(b) the diagrammatic outline of a manufacturing business?

Upon what fundamental idea is scientific management based, and what are some of its features?

CHAPTER III

PROBLEMS OF COST FINDING (*Continued*)

1. *Basic cost problem similar in all industries.*—It will be noted, therefore, that the problem of cost finding in the factory is little different from that of the farmer previously discussed. The difference is one of degree rather than one of principle. Competition has, however, compelled the factory owner, in general, to look more closely into his costs; the agriculturist will soon be compelled by the same economic pressure to do likewise.

Industrial enterprises, of course, vary widely, not only in the character of the work they pursue but also in the way in which they are organized and departmentized. Furthermore, as will be shown, no single cost-finding system can be devised that will be suitable for all enterprises. The importance of understanding correct basic principles is therefore apparent.

2. *Other relations to general accounting.*—The problem of cost finding will be more clearly understood, also, by considering certain other characteristics of manufacturing industry. As before noted, the general accounts indicate the general condition of the business and should also, if properly conducted, indicate the general tendencies of the business. Figure

3 (page 27) shows a typical monthly statement of the affairs of a manufacturing company. In it the condition of the assets and liabilities of the company under consideration have been summarized. Among the "fixed" or "permanent" assets are found such items as buildings, machinery and tools, drawings and patterns, shop furniture and fixtures. These assets are not permanent, however, in the sense that their value does not change. As a matter of fact, they are constantly being added to and are constantly depreciating in value either from use or from decay. Much of the labor expended in the construction and repair of these utilities is the work of men regularly employed and much or all of the material used passes thru the regular channels of purchase and storage. Some of these expenditures of labor and material, however, are expenditures on the capital account and add to the value of the assets. It is important that the value of these expenditures be known as closely as possible, and hence they must not be confused with those connected with the manufacture of product for the market. Cost finding, therefore, is concerned with, and must take account of, many other things besides production for the market.

Again, on the monthly statement are found the values of raw materials, material in process, and finished product; that is, the value of all raw or unworked material, the value of all material passing thru the shop and partly worked into finished product, and the value of all material fully completed and

MONTHLY STATEMENT, BROWN MFG. CO.												
	MARCH 31, 191-						APRIL 30, 191-					
	DR.			CR.			DR.			CR.		
PERMANENT ASSETS												
REAL ESTATE	60	500	00									
BUILDINGS	200	225	00									
MACHINERY AND TOOLS	150	345	00									
FACTORY FURNITURE	7	240	00									
OFFICE FURNITURE	2	100	00									
DRAWINGS AND PATTERNS		100	00									
TOTAL	420	510	00									
CURRENT ASSETS												
CASH	7	241	52									
STOCKS AND BONDS	2	500	00									
NOTES RECEIVABLE	1	250	50									
ACCOUNTS RECEIVABLE	75	240	30									
RAW MATERIALS	40	264	18									
MATERIAL IN PROCESS	50	146	15									
FINISHED PRODUCT	20	240	24									
GOODS ON CONSIGNMENT OUTWARD	5	140	10									
DEFERRED CHARGES	1	240	00									
TOTAL	203	262	99									
PERMANENT LIABILITIES												
FUNDED DEBTS												
MORTGAGE BONDS				10	000	00						
MORTGAGES				5	000	00						
TOTAL				15	000	00						
CURRENT LIABILITIES												
NOTES PAYABLE				35	000	00						
ACCOUNTS PAYABLE				52	246	15						
PAYROLL				3	218	16						
TAXES ACCRUED				1	240	12						
INTEREST ACCRUED					400	20						
RESERVES				1	240	14						
TOTAL				93	344	77						
NET WORTH												
CAPITAL STOCK												
COMMON				375	000	00						
PREFERRED				100	000	00						
SURPLUS AT FIRST OF YEAR				21	245	16						
NET PROFIT TO DATE				19	183	06						
TOTAL				515	428	22						
GRAND TOTAL	623	772	99	623	772	99						

FIGURE 3

in the stockroom. Obviously the general accountant has no place in his books for the myriad accounts of details occasioned by the constant flow of material thru the shop. Yet it is important that this information be at hand periodically, and it must be correct if it is to be of any use. Formerly it was considered sufficient if the balance sheet were drawn off yearly, the value of all material, raw, worked and in process being commonly obtained by actual, visual appraisal. While such an appraisal is still a very valuable procedure as a check, every modern accounting system requires a monthly statement like Figure 3, and some of the items shown can be obtained only thru a cost-finding system that keeps constant and accurate account of all movements of material and all expenditures for labor. The cost keeper carries a separate account with each individual factory order, recording its increasing value as it progresses. When the accounting period arrives he adds up his accounts, checks the balances against the total value of material issued from stores and the labor expended, and reports the total amount to be transferred from "material" to "work in progress" and from "work in progress" to "finished product."

The monthly statement illustrated in Figure 3 shows in a concise manner the status of all of the important activities of the business. Clearly, good cost finding should not stop at recording the values of the items just discussed. Just as Figure 3 is of great value in judging the general tendencies of the busi-

ness, so more detailed reports of the several activities of the enterprise show the reasons for these tendencies, and the furnishing of these detailed reports is a most important function of a good cost-finding system.

3. *Functions of cost finding summarized.*—It appears, therefore, that the requirements of a good cost-finding system extend far beyond the ability to find the cost of marketable product. Its function as a means of predicting future performance has already been noted and to these may now be added the third function, namely, that of supplying a basis for managerial reports. Summarized, then, these requirements are:

(a) To record the results of operations.

(b) To furnish a basis for the prediction of future operations.

(c) To supply a basis for managerial reports.

The last two items will be discussed in a later section and the discussion for the present will be confined to the first item. The relation that should exist between the general books and the cost books will be clearer after a discussion of the problems of cost finding, so this topic will also be deferred.

4. *Complexity of costs.*—From what has been said it is clear that the cost of any manufactured article is a complex quantity. The manufacturer buys supplies which he classifies as raw or unworked material. On this material a certain amount of actual labor is performed by his men. Obviously it is not difficult to obtain a fairly accurate account both of the cost of the

material used and of the actual labor bestowed upon it, since these two elements of cost are paid for directly in money. But, in addition, it appears from Figure 2 (page 21) that many men must be employed who do not work directly upon the product, yet their wages are certainly a part of the cost of production. In addition also to the material that goes directly into the product there is much material that must be used to carry on the work, tho it does not enter into the product. Thus coal, oil, waste, etc., are chargeable against production, tho they do not enter directly into the product. And, finally, there are many other items of expenditure, such as insurance and taxes, that are neither labor nor material, but which must be included in the completed cost, tho they cannot be connected directly with any particular piece of product.

5. *Direct and indirect material.*—Material which enters directly into the product is known as direct material or more simply as material. All material which is chargeable against production, but which does not enter directly into the product is called indirect or expense material.

Occasionally material enters directly into production in such small quantities as to make accurate accounting impracticable. Thus glue, screws, nails, etc., may be used directly in production but not in quantities large enough to be worth noting, so far as any one piece of product is concerned. They are then treated as indirect material.

The iron, copper, insulation, etc., that enter

directly into the construction of a machine would be classified therefore as direct material. The coal used in heating the factory and the oil used in lubricating the machinery of production, while not entering directly into the construction of the machine in question, are essential to its production and a portion of them are justly chargeable against it; they would be classified as indirect material.

6. *Direct and indirect labor.*—Labor which is expended directly upon the product is called direct labor, productive labor, or more simply, labor. Thus the work of a machine operator would be classified as direct labor, and his wages would be chargeable directly to the parts on which he works, in proportion to the time he spends.

All labor chargeable against production, but which is not directly connected with some particular piece of work, is called indirect or nonproductive labor. For example, the wages of firemen, crane tenders and clerical assistants cannot, in general, be connected with any particular piece of production. Yet they are just charges against production and must be included in the costs.

The terms "direct" and "indirect" are much preferable to "productive" and "nonproductive." All labor is productive, strictly speaking, tho it may not all be expended directly on the product.

7. *Burden or expense.*—It is not difficult to allocate the direct labor and the direct material which go into any piece of product, but it is exceedingly difficult,

often, to charge each piece of product with its correct share of indirect material, indirect labor and the other items of expense not directly connected with production, such as clerical salaries, insurance, etc. All these indirect charges are, therefore, usually gathered into lump sums, as will be described hereafter, under the name of burden, overhead expense or, more simply, expense. The great problem of cost finding is to distribute this burden or expense properly and justly over the product so that each article shall bear its own share, and only its own share, of expense. In general this cannot be accomplished with great accuracy, but, as will be seen, approximations can be made that are sufficiently accurate for most cases.

8. *General classification of expense.*—The cost of the selling department and the accounting department is of the indirect kind, and hence is included in the expense. But, as has been noted, these functions are independent of production, are under their own officers, and the latter should be held strictly accountable for their own expenditures. The manufacturing superintendent should be held accountable only for the costs of actual production, and the cost books should show the relative proportions of expense chargeable to each department. Expense, therefore, is divided into manufacturing or factory expense, administrative or office expense, and selling expense. In many instances the administrative expense is small compared with the selling expense and the two are grouped together under the name of general or com-

mercial expense. It will be assumed for the present that this grouping is sufficiently accurate for the discussion that follows, but the general principle should be borne in mind. It is often highly important that the cost of the sales should be carefully separated from the administrative or office expenses, in order to locate expenditures accurately and to fix responsibility beyond question; and where the selling expense is large compared with other expenses this separation should always be made.

9. *Elements of total cost.*—It appears, therefore, that the most natural primary divisions of manufacturing cost are direct material, direct labor, and manufacturing or factory expense. It is often customary to omit the qualifying word and speak of direct material and direct labor simply as material and labor. The sum of the direct material and the direct labor is known as the flat or prime cost. The sum of the prime cost and the factory expense is the shop cost, known also as the factory cost or manufacturing cost. The factory cost includes all expenditures for which the manufacturing superintendent is held responsible. The factory cost includes, therefore, all items properly chargeable against the product up to the time of its delivery upon the shipping floor, or to the stockroom according to its destination. The sum of the factory cost and the general expense is the total cost, and the total cost plus the profit is the selling price.

Naturally the relative proportions of these several

items will vary with the enterprise. In Figure 4, below, the relation of these items is shown graphically, and while the figures are taken arbitrarily, they are suggestive of the relative proportions found in general machine production.

The items which should be included in the total cost

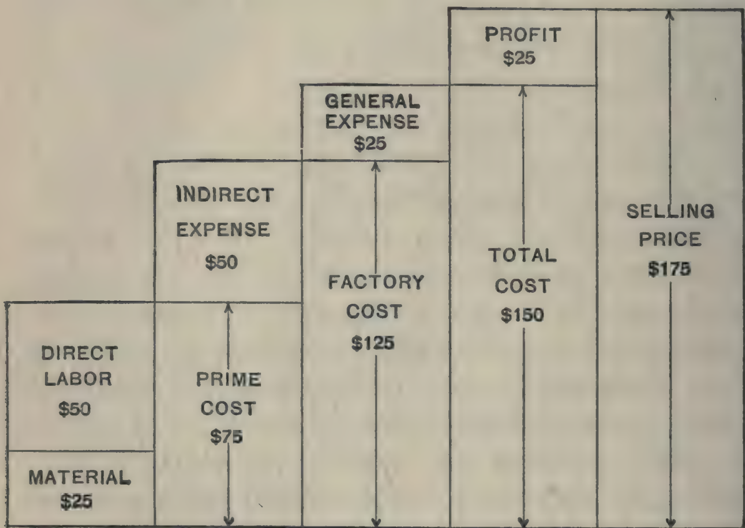

FIGURE 4—ELEMENTS OF MANUFACTURING COST

are necessarily fixed by the nature of the product, the processes of production, the efficiency with which the works are operated, and the cost of marketing the product. Profit, on the other hand, is somewhat arbitrarily fixed, but is closely connected with the volume of business transacted, a feature that is often lost sight of. Suppose, for instance, that the total cost of the

product for one year is just equal to the amount for which the business is capitalized, and on which it is desired to pay, say, six per cent profit. Obviously, if the total cost of the product is increased by six per cent in order to fix the selling price, this object will be accomplished. On the other hand, if the total cost for the year is small compared with the capitalization, the percentage to be added must be increased proportionately; while if this total is great compared with the capitalization it can be reduced in like ratio. The value of the output per dollar of inventory is, therefore, a very important matter. It is not sufficient that the material and labor value of all product be low. The volume of the output must be sufficiently great so that the profit which must be added will not bring the selling price above what the market will stand.

10. *Methods of adding profit.*—The method of adding the profit to the total cost as a percentage on that amount should be carefully noted where it is desired to use the selling price, instead of the total cost, as a measure of the profit. Suppose, for instance, that the total cost is \$100 and it is desired to make twenty per cent on the sales price in order to realize the proper returns on the capital invested. If twenty per cent of the total cost is added to the total cost the selling price will be \$120 and the profit will be \$20, which is not twenty per cent of the selling price. If, however, twenty-five per cent be added to the total cost, the selling cost will be $100 + (.25 \times 100) = \$125$. The profit will be \$25, which is twenty per cent of the

sales price, and the profit will be correct in its relation to the desired returns on the investment. Operations of this kind, involving percentage, should be carefully considered, for they are a fruitful source of error and loss. Obviously, these calculations are simpler and safer when the total cost is used as a basis of computation.

In general, if s be the sales price, c the total cost, and x the percentage on the sales price that it is desired to obtain,

$$\text{then } s - c = x\,s$$
$$\text{whence } s - x\,s = c$$
$$\text{and } s = \frac{c}{1 - x}$$

which may be used for computing the sales price when the total cost and the percentage are known.

REVIEW

What are the elements of prime cost? of factory cost? of total cost? of selling price? Prepare a diagram expressing the relation between the factors of selling price, and compare your result with the diagram in the text.

How would you allocate the following items of expense in a silk mill: raw silk purchases; dyeing; coal; commissions to salesmen; heat and light; weavers' wages; purchases of lubricating oil; superintendent's salary; general office salaries?

How would you work out a practical illustration of profits figured on both cost and selling price? Which, in your judgment, is the more accurate method?

Why are the terms "direct" and "indirect" preferable to "productive" and "nonproductive"?

CHAPTER IV

IDENTIFICATION OF COSTS

1. *Classification of accounts.*—From the foregoing it is obvious that cost finding is concerned with two kinds of accounts. Those that have to do with the actual production are constantly changing, a new account being opened with every new undertaking and closed with its completion. On the other hand, the accounts that have to do with repairs on buildings, maintenance and repairs of equipment and similar matters are permanent in their character, continuing as open accounts so long as the enterprise lasts. The same is true of labor expense and material expense which cannot be allocated to any particular piece of work. They are expenses which flow constantly, without change in their characteristics.

The first step, therefore, in establishing a cost system is to make a careful classification of these accounts. This classification will, necessarily, conform in its general outlines to the manner in which it is desired to have all transactions appear in summarized form in the general accounts, and also to the character of the statistical information which it is desired to col-

lect. The classification [1] will also necessarily vary in character and detail, according to the size of the enterprise and the character and variety of its product. The classification for a mercantile establishment will not be quite the same as that for a factory manufacturing machinery. The following is a typical classification of the general ledger accounts as found in enterprises of the latter class, with a few of the characteristic subheadings to show the kinds of charges belonging under each heading. A more comprehensive list is used by large manufacturing enterprises; one large electrical manufacturing establishment has over two hundred and fifty of these accounts. The justification of this large number lies in the fact that what may be a small item in a small plant may amount to many thousands of dollars in a large one, and the possibilities of saving more than offset the cost of segregating the accounts. This is especially true of the expense accounts. The monthly statement, Figure 3, is, of course, a summarized statement of these accounts, arranged so as to show the totals of the several classes with only such detail as appears to be indispensable.

[1] For examples of such classifications see "Factory Organization and Costs," by J. Lee Nicholson, p. 203, and also "The Science of Accounting," by H. C. Bentley, p. 85.

LEDGER ACCOUNTS OF A MANUFACTURING ESTABLISHMENT

ASSETS

Permanent	Current
Land	Cash
Buildings	Notes receivable
Machinery and equipment	Accounts receivable
Office equipment	Treasury stock
Patent rights	Consignments (outward)
Development expenses	Finished product
Organization expenses	Goods in process
	Unworked material
	Factory supplies

MISCELLANEOUS

Deferred charges	Advertising prepaid
Interest prepaid	Securities owned

LIABILITIES

Permanent	Reserves
Mortgages payable	Doubtful accounts
Bonds	Depreciation

Current	Net Worth
Notes payable	Capital stock, common
Accounts payable	Capital stock, preferred
Accrued interest	Surplus
Accrued taxes	Profit and loss

REVENUE ACCOUNTS

Sales of product	Miscellaneous income

Sales of by-product

EXPENSE ACCOUNTS

Manufacturing Expenses

Direct material	Depreciation
Direct labor	Repairs
Indirect labor	Insurance
Factory clerical wages	Taxes
Factory supplies	Etc., etc., etc.

Selling Expenses	Administrative Expenses
Salesmen's salaries	Officers' salaries
Traveling expenses	Officers' expenses
Agents' commissions	Directors' fees
Advertising	Clerical wages
Postage (used in selling)	Office supplies
Freight	Office rent
Cartage	Postage
Incidentals	Legal expenses

2. *Formation of subsidiary ledgers.*—It is obvious that the ledger accounts or controlling accounts, listed above, are necessarily fed from many sources. Thus if a piece of land or a new machine is purchased the transaction does not pass thru the manufacturing organization but is conducted thru the manager or superintendent directly with the real estate agent or the machine builder. The purchase price is added to the proper account under permanent assets and the cash account, if it be a cash transaction, is lessened by the corresponding amount. If, however, the machine is built in the shop, as is frequently the case, a quite different procedure is adopted and care must be exercised that the correct cost of manufacture is obtained by taking account of all direct and indirect material and labor expended in its construction. If proper sales prices are to be fixed for goods manufactured for the market, the cost of every article manufactured must be ascertained, and if the general accounts are to be balanced frequently the value of all material—finished, in process and in the raw state—must also be evaluated frequently.

If the enterprise is small all of these requirements can be met by accounts in a single general ledger, the detail items under each account being consolidated to permit such treatment. But as any establishment grows it becomes increasingly necessary to go into greater and greater detail, and subsidiary ledgers are opened to handle this detail the summarized statements of which may be carried to the general ledger. Thus it is often desirable, as explained in the Text on "Accounting Principles," to open one ledger for accounts receivable and another for accounts payable. The cash transactions are often kept in a separate cash book and a separate ledger may be necessary to keep proper account of the machinery and equipment. The number and character of these auxiliary ledgers will depend entirely on the size of the business and the character of the output.

3. *Separate cost records.*—When, therefore, the details of the cost of the product become too voluminous for the general books some form of independent account must be opened for each individual job or order. This series of accounts may be kept by means of a card-index system or they may be kept in a bound volume, but in either case such a set of accounts is usually called a cost ledger. Just when it becomes necessary to open such a ledger cannot be definitely fixed, but depends again on the circumstances of the business. There is a general tendency, however, to separate the cost-finding system from the general books, even in certain kinds of small plants, for rea-

sons that will presently appear. The extent to which this is necessary is also much affected by the character of the manufacturing processes and the consequent organizations of the enterprise. Manufacturing plants may be divided, broadly speaking, into two kinds, namely:

(a) Continuous-process industries.

(b) Intermittent, or interrupted, process industries.

4. *Continuous-process industries.*—In a continuous-process industry of the extreme type the materials are passed in a steady stream thru a process or sequence of processes. The raw material goes in at the receiving end of the plant, is worked continuously, and appears as finished product at the shipping end of the plant. Thus a cement plant is supplied with a constant stream of the necessary ingredients, passes them all thru the same processes and produces a uniform product, so far as appearances, at least, are concerned. Ore-refining plants, oil refineries, salt works and sawmills are other examples of this kind of industry.

Such an industry may be either analytical or synthetical. That is, it may take some natural product and separate it into component parts, as in the case of ore refining or of industries turning out products made from salt; or it may take raw materials and build them up synthetically into other products, as in the case of a paint works. Usually such factories

handle only a few materials and these in very large quantities.

In the extreme case where the processes involved are not numerous, and the quantities handled are vast and of few kinds, the cost finding is very simple. All that is needed is the cost per unit (yard, pound, or ton, as the case may be) and this involves only a record of the output for the period considered and a record of the labor, material and expenses incurred for the same period. If the value of the material in process is not great the unit cost can be ascertained accurately enough by dividing the summarized labor, material and expense by the output for the period selected. If, however, the value of the material in process is great, allowance must often be made for this value, especially if the rate of production varies. Clearly the cost finding, even in such cases, need not extend beyond the general books, and in simple cases it is not necessary to keep the expenses of production in any great detail, since these expenses are necessarily distributed uniformly over the product.

There are often administrative reasons, however, for keeping detailed costs even in these simple cases. Thus, in some continuous industries it is desirable to know the cost of production by departments or processes; or the plant may be producing several articles continuously, each article passing thru the same departments. In such cases simple division of the summarized cost, as already indicated, may not suffice

and cost-finding methods apart from the general books must be resorted to.

5. *Intermittent-process industries.*—At the other extreme are industries that manufacture a variety of products and a comparatively small number of each variety. A plant for the building and repairing of ships is a good example of this extreme type. Here duplication of an order is not frequent and the greatest diversity of product is met with, as regards both character and size. Obviously, only cost-finding methods that take account of the labor, material and expense that justly belongs to each job are adequate in such cases. The degree of detail into which it is necessary to carry the cost-finding methods will, of course, vary greatly with the character of the work, but, evidently, no simple averaging methods, such as have been discussed, will give even approximate costs in cases like this. The various items of shop expense are chargeable in varying degree to the many articles made, and, while it is not difficult to allocate the material and labor actually used on any contract, the distribution of the indirect expense presents a difficult problem.

6. *Combined intermittent and continuous factories.*—Between these two extremes are found many enterprises that employ both intermittent and continuous processes to a greater or less degree. Thus a large electrical-machinery factory may build large-sized generators, motors or transformers, to order only, and seldom in lots of more than three or four.

On the other hand, it may also build a large number of small motors or transformers, these articles not being in continuous production, but passing thru in large lots as needed. Large numbers of finished parts may be made at any one time and placed in the storeroom to be assembled whenever desired. Again, certain processes such as annealing and dipping in insulation may be in constant operation, like a continuous process, tho all the sheet steel passing thru may be handled and identified as belonging to certain specified lots and intended for specific jobs. The porcelain works of such a factory, if they were making porcelain parts of approximately the same size, might very well be treated as a continuous industry and the cost of its output might be computed by the unit plan, as in the extreme continuous industries discussed above. The same procedure might be followed in the foundry, if the manufacturing conditions were analogous and no great variation in the size and character of the product existed.

Obviously the conditions in such a factory are complex, and the cost system that will be adequate for such a place needs careful consideration and may include characteristics of more than one method of cost finding. Clearly, also, no single method of cost finding is applicable to all kinds of industry, and many practical modifications must often be made in cost-keeping theory in order to obtain a workable system. In many cases exact results are not obtainable, because of such complexities. There are, however, cer-

tain fundamental conceptions that are helpful in all cases.

7. *Blanks and forms for cost finding.*—It is obvious also that, where a factory is highly departmentized, as in Figure 2 (page 21), special means must be employed to coordinate the work of the several departments and to insure that correct information will go to the right persons and to those persons only. Such information cannot be carried orally, but must be transmitted by means of systematized blanks and printed forms. Furthermore, the amount and character of the "system" used will vary widely with the character of the industry, the size of the plant and its particular form of organization. The card or form that will be excellent for a particular purpose in one factory will be useless for the same purpose elsewhere. No effort is made here, therefore, to illustrate such forms or blanks except as it is necessary to illustrate general principles. If the purpose of the blank can be clearly determined the exact form of the ruling and of the printed content is a matter of clerical work only; tho, of course, much valuable information and assistance can be obtained from the collections of such documents that are found in specialized books on cost finding and on accounting.

Even where the cost-finding system is elementary, and does not extend beyond the general books, it is important that the blanks and forms used in administration be made with the cost system in mind. Much

valuable time is often wasted in copying and recopying instructions or records that should appear in the required form as a natural result of the system. When, however, the detail costs required are such as to warrant the employment of a cost keeper, and the opening of special ledgers, such as the stores ledger and the cost ledger, the forms and blanks used must cover thoroly the system introduced. The manufacturing superintendent is concerned with placing proper orders for producing machines. The cost keeper is concerned with the detail in which these orders are given, since on the detail in which the order is given must rest the detail in which his cost will be recorded. The set of forms, therefore, should serve both purposes, namely, that of carrying the correct information as to the method of doing the work, and at the same time that of segregating operations in such a manner as to allow the intelligent recording of costs. No one thing is so fatal to system of any kind as complexity. Every effort should be made, therefore, to keep the number of the blanks down to a minimum consistent with the absolute requirements of the situation.

8. *Two classes of blank forms.*—A large manufacturing enterprise may employ a great number of these blanks and forms, and to the uninitiated this vast array is often very confusing. There are, however, only two general types of such documents and it will assist materially in an understanding of complex systems if these blanks are classified into:

(a) Orders, or instructions as to how work is to be done.

(b) Returns, or records of how work has been performed.

Orders include all instructions or advice emanating from all departments and officials that are charged with directing the work. Thus, the drawings and specifications issuing from the drafting room, and the information regarding shipping dates and destination of product, may be regarded as orders, just as much as the specific orders that must be given to a mechanic regarding a particular piece of work. It may be further helpful if these orders are considered as moving downward in Figure 2 (page 21) over predetermined paths, each one carrying its information accurately to the right parties and to them only. In large organizations it is now common to make such a chart as Figure 2 and lay out such paths; also to specify the character of the orders that are to move along each one. Figure 10 (page 92) illustrates a production order issued by the order clerk (Figure 2), instructing the foreman of some department, perhaps, to proceed with some operation. The production order carries the number, letter or other characteristic which identifies the work, whether it be a lot of machines, a single machine, or a part of a machine and, obviously, the detail in which it is made out will govern the detail in which the returns can be made.

Returns include all statements which give the re-

sults of operations or the records of material used, whether for direct product or for supplies; also records of time expended and wages paid. Returns may also include all summarized reports and similar documents. These returns have their origin where the work is being done and where material is being drawn from stores and worked into finished product. It may assist in the visualizing of these matters if returns are considered as moving upward from the points where the actual operations are performed, being constantly consolidated into briefer statements till they are merged into the general books and general consolidated reports. Figure 12 (page 125) shows a typical work card on which may be recorded the amount of time expended on any given operation and the rate of pay which the operator is to receive. This card bears the order number or letter which has been assigned to this particular operation and piece of work and is, therefore, a basic factor in cost finding, whether it refers to a lot of machines or a minute detail of any one of them.

9. *Necessity of identifying work.*—If costs are to be obtained, whether of large lots of machines, a single machine, or of each part of a machine, some means must be provided for identifying the lot or machine or part. No two machines or parts may bear the same distinguishing mark, and if many thousands of pieces are passing thru the works at any one time it is obvious that some system must be adopted that will be capable of great expansion without danger

of repetition. Furthermore, constant reference must be made to the several departments of the factory. To write the names of these departments out in full would take too long and would be a waste of labor. It is customary, therefore, to refer to departments by number or symbol. Again, in making up shop orders it is necessary to specify the operations, or sequence of operations, on each piece. This also may involve reference to tools and equipment. In a large works the tools and equipment may be many and diverse, including many special jigs, fixtures and similar apparatus; the number and character of the operations performed may also be many and varied. Furthermore, the materials used may be of many kinds and, since constant reference must be made to them, they also should be the subject of abbreviated nomenclature. With the constant and rapid growth of the methods of planning all operations in advance, as advocated by modern production engineers, these last items assume great importance in factory administration. The more accurately all machines, operations and materials are identified, the more accurately and easily can productive costs be allocated. The laying out of a good system of identification is, therefore, a necessity, whether viewed from the standpoint of operating administration or of cost finding.

10. *Mnemonic symbols.*—There are several identification methods now in use. In many places the departments are known and referred to by simple letters, such as A, B, C, D. Where only a few departments

are to be handled this method is adequate. If the departments are numerous, and it is desired to apply numerical identification to other lines, a system of mnemonic symbols is often employed. Thus the letters T A might be used to indicate the transformer-assembly department, the letters S M might indicate the screw machine department, and so on. Similar abbreviations are commonly employed to indicate the materials used. Thus C I indicates that the part is cast iron; M S, that it is of machine steel.

The problem of identifying operations is a little more complex. If only a few operations are in use, mnemonic symbols are adequate and are often used. Thus TN may signify turn, BO may mean bore, GR may signify grind, and so on, each enterprise compiling symbols suited to its own operations. Sometimes the use of symbols is obviated by printing all the operations on the side of the cards which give instructions or record returns, as illustrated on the work card, Figure 14 (page 130), in such a manner that the facts may be indicated by a check mark. This method also saves writing, but its use is limited to industries involving standard operations.

The problem of identifying departments or operations is, in general, an easy one compared to that of identifying the products and parts of products, particularly in large plants doing a wide range of work. In factories which make large products, such as steam engines, and where a comparatively small number of machines are being produced at any one time, mne-

monic methods are sometimes used. Thus, in some shops of this character the term "Osp" might be used to designate all drawings for an engine built for a certain hospital, and each drawing might bear this symbol followed by a serial number which would locate the drawing in the series belonging to that engine, the drawing serving as a basis for production orders and cost charges.

11. *Drawing numbers.*—In large factories with a variety of products, however, these simple methods of identifying machines and machine parts fail completely, and identification must usually rest upon a carefully arranged system of drawing numbers, so-called. In a very large works where many thousands of drawings are made yearly, this necessitates a careful consideration of the entire manufacturing problem, and perhaps the separation of the product into distinct classes. Here mnemonic or, in fact any, system of symbols based entirely on letters is usually inadequate or too cumbersome, and numbers, or combinations of numbers and letters, are used. Thus the symbol K 24,689 might, in such a system, identify the drawing of a steam-engine cylinder, the letter indicating the class of product, and the numerical part indicating its place in the series. Sometimes, again, all drawings are numbered serially and an index is kept which shows the serial numbers of the drawings used for each machine. The drawing of any part may be found by looking at the index of the drawings that were used in making the machine and

finding the serial number of the particular drawing on which the part would be found. Sometimes, too, a numbering system based on the Dewey decimal system of classification is used, certain classes of numbers being set aside for certain blocks of machines or product. Thus, all numbers beginning with .012 might indicate transformers and all numbers beginning with .013 might indicate oil switches. In practice the decimal point is omitted for convenience, and the integers in the number are always preceded by a cipher. The Dewey system has the advantage of unlimited expansibility without repetition; it can be made as comprehensive as may be desired, and hence is well suited for large works. The system that is best for one shop may not apply to others, however, and each case requires special study in order that the system may be made comprehensive without being cumbersome.

Whatever the general method of classifying the drawings, each drawing may carry more than one part, tho in some systems only one part is put upon each drawing. Where more than one part appears on a sheet each may be identified by a part letter. Thus, in such a system, K 24,689-A might signify part A on drawing 24,689 of the class of product indicated by K. This identifies the part beyond question, making it possible to charge with accuracy all labor and material that enters into its production.

12. *Drawing lists.*—In most well-organized shops using methods of this kind, the engineering department originates the directions governing the construc-

tive features of the work, and turns over to the construction department full drawings and specifications in such detail that every part may be identified, not only during actual construction, but for all time, so long as the drawings are existent. In highly developed systems a drawing list, Figure 5 (page 55), accompanies the drawings and specifications. Such a list constitutes a complete inventory of the parts that are to be made, and is an index to the drawings and lists, where the parts may be found in detail. Thus in Figure 5 the number of the drawing and that of the part or piece, are listed, the material of which the part is to be made is noted, and the number of the parts required is given. Reference is also made to the engineering and other specifications that accompany the drawing. Figure 5 illustrates a system which used the Dewey decimal method for numbering drawings, but which uses a combination of letters and integers for other documents, such as tabulated data and engineering specifications.

It will be noted that such a method allows the free and convenient use of any one part in the construction of any machine, whether designed originally for it or not, since identification is complete. Thus, in Figure 5 the armature and field are taken from one series, the shaft and bearings are taken from other series, and still other parts were made originally for other classes or sizes of the same type of machine.

The nomenclature given in Figure 5 has been taken at random, but it is a probable combination. In well

DRAWING LIST NO. 4

MACHINE	TYPE	CLASS	VOLTS	DATE
Generator	M.R.P.	10-400-650	2200	4-11-1916

NAME OF PART	DRAWING NO.	PATTERN NO.	PART NO.	NO. OF PARTS	MATERIAL	DATE ADDED	DATE CHANGED
MACHINE COMPLETE	012						
" OUTLINE	0121						
ARMATURE COMPLETE	0122						
" DIAGRAM	0123						
" FRAME	0124		a	1	CI	8-24-14	
" PUNCHING	0125		B		No.2S		
BASE	0034		a	1	CI		
BEARING	0035		B	2	CI		
BRUSH							
BRUSH HOLDER							
" STAND							
" STAND SUPPORT							
" STAND BRACKET							
" STUDS							
" YOKE							
CABLE							
" FOR FIELD							
" COUPLING							
COLLECTOR	Table	P468	m	2			
CONNECTION BOARD	Table	R246	n	1			
COUPLING	Table	n428	R	1			
FIELD SPIDER	0126		a	1	SC	8-24-15	
" RING	0127		B	1			
JACK SCREWS	Table	S26	a	2			
LAMINATED POLES	0128						
PULLEY	Table	48	R	1			
RAILS							
SHAFTS & KEYS	0346		a	1	MS		8-16-15
SPOOL COIL	0267		B	1			
STANDARDS & CAPS	0436		C	2			
WRENCHES							
Armature Shields	0074		B				9-12-14
Sub-base	0346		a				
Woodenbase-frame	0014		O				
LIST OF CASTINGS			00				
ARMAT. WIND. SPEC.	a 4684						
FIELD WIND. SPEC.	B2678						
ENGINEERING NOTICE	m 46						

FIGURE 5

standardized production such lists may be printed in outline and the data filled in by hand. Thus in Figure 5 the data that would be so filled in is indicated by script. It will be evident that the shop orders governing the production of the machines, as a whole or in part, as the case may be, and the shop returns recording the details of such production, can be made out with the assurance that, so far as identification is concerned, the correct labor and material charges will be recorded against the cost of the part concerned.

13. *Mnemonic and number systems compared.*—The relative merits of mnemonic symbols and numerical identification should be noted. No doubt, in the cases where the number of items is small and where it is desirable to remember departments or operations, the mnemonic system is useful. For this reason it is often used to identify departments and operations. It is also used to identify expense orders. Thus all charges against buildings can be carried in account B, and all charges against power, heat and light, against account P. H. L. In large factories, however, where it is necessary to separate the expense into many items, it becomes necessary to use numbers. Thus the labor report, Figure 25 (page 293), lists the expense by numbers, while the direct labor is charged against the letters which identify the several classes of product.

Obviously, the degree of detail needed in the nomenclature of a factory depends entirely upon the character of the enterprise. In simple, continuous indus-

tries few details are required in the nomenclature, while in large, intermittent industries it may be necessary to go to all the detail which has been described. Whatever system is adopted it should identify each part beyond a doubt, and it should be capable of extension as the industry expands. To change the system of nomenclature and identification is always a troublesome problem and one that can often be avoided by a little foresight.

It is important to have clearly in mind the principles that have been discussed in this chapter, since upon them depend the methods used in collecting the material and labor charges, whether against the job as a whole or against any detail. The need of such detailed methods of identification will be clearer after a discussion of the principal items with which cost keeping is concerned, namely, materials, labor, and expense.

REVIEW

Under what headings would the following accounts be placed: Advertising; office expenses; land; treasury stock; taxes; accrued taxes; factory supplies; salesmen's traveling expenses; sales of product?

What are the characteristics of a continuous-process industry? of an intermittent-process industry? of a combined continuous- and intermittent-process industry?

For your own information, classify the following industries as continuous-process industries or intermittent-process industries: a shoe factory making one grade of men's shoes; a shingle mill; a chemical factory; a tannery.

How would you designate the following expense accounts of both a wholesale and a retail sales department, by mnemonic

symbols: salary of manager; clerk's wages; traveling expenses; advertising; rent; light; telephone; miscellaneous?

What system for the identification of drawings would you prefer to adopt? Why? How would you illustrate the method to be adopted in the case of some machine with which you are familiar?

Can you draw up from memory a model form of comparative monthly statement, allocating the items under proper captions?

CHAPTER V

PURCHASING MATERIAL

1. *General.*—The first step in the production of any article is to obtain the necessary materials. All industrial effort is concerned with the transporting of physical materials and their transformation into other forms in which they are more serviceable. Material in the natural state usually possesses potential value only. As labor is bestowed upon it the material rises in value; in fact, practically all industrial values are principally labor values. Thus, a pound of iron ore in the side of a hill has potential value only and may be bought for a fraction of a cent. This same iron ore when smelted into cast iron may be worth a cent per pound; when manufactured into Bessemer steel it may sell for one and one-half cents per pound. If made into crucible steel it may be worth sixteen cents per pound, and if made into watch springs it will be worth many dollars per pound. This is true of all manufactured products. Industrial values are, largely, accumulated labor values; the value of the material in the original, natural state is a small part of the final value.

In the great majority of industrial pursuits the production of marketable products is divided into many

stages, only a limited number being performed in any one plant. In a few cases, such as cement works and salt works, the transformation from the natural product to the finished article is performed in a single plant. But in the majority of cases, most market products are the results of several distinct stages and these stages may be separated widely, both geographically and by characteristics. The material that is required for a large electrical works, for instance, is of tremendous variety and is gathered from many sources. Practically all of it, however, has had more or less labor expended upon it before it goes to the factory. The articles which one manufacturer looks upon as finished product may be looked upon by other manufacturers as supplies or raw material, and the extent to which any manufacturer may control the sources of his supplies will vary greatly. Probably no industry exists today that is not dependent in some measure upon other industries for some portion of its supplies, and the extent to which it will pay any given manufacturer to engage in making what will normally be considered supplies is an interesting industrial problem that lies outside the scope of this discussion.

Since material represents value, just as much as cash in the safe does, it would seem to be unnecessary to urge that proper supervision be exercised over all operations involving its purchase and use. It is true that in many industries where the material used is very cheap, crude methods of finding material costs will suffice. But, on the other hand, it is amazing to

see the complacency with which some factory managers view material wastes in the factory, involving thousands of dollars, while exercising the greatest strictness to avoid the loss of a cent in cash. Wastes of this kind go on day after day in some shops, but any effort to stop them by means of intelligent supervision would instantly be met with opposition on the ground of unnecessary expense. No well-regulated enterprise in which the materials used are an important financial factor, can afford to be without a cost system that takes cognizance of all material from the time it is ordered until it is shipped as finished product.

2. *Importance of purchasing.*—It would seem unnecessary, therefore, to urge that purchasing, the first step in the process of production, should be conducted with skill and foresight. It is not possible to discuss in this book the art of purchasing, but certain phases of purchasing must be considered here since these bear directly upon costs and cost finding.

Whatever the size or character of the enterprise the purchasing should be centralized. Where this power is delegated to several persons, or left to any one on whom the responsibility may happen to fall, economical results cannot be obtained, and the first opportunity to secure low costs is surely lost thru loose and extravagant methods.

It should be remembered, also, that successful purchasing in an industrial establishment involves more than natural purchasing skill and a knowledge of

markets. A successful purchasing agent should know intimately the processes and operations for which he is buying material, and he should be furnished, whenever it is possible, with carefully prepared specifications in regard to the material which he is to purchase. Not only does such knowledge enable the purchasing agent to guard against actual mistakes but also to discriminate knowingly between the several kinds of material that may be offered and which seem, superficially, to be much alike.

Of equal importance is a knowledge, on the part of the purchasing agent, of the article which is to be purchased. A man might be very well qualified to buy building material but be wholly unfit to purchase electric motors. And this knowledge of the article to be purchased may need to extend to a clear understanding of the processes by which it is produced, to enable the purchaser to judge whether or not a bidder is adequately equipped to fill the contract under consideration.

The technical knowledge required by a purchasing agent may, in many industries, be very great, and a purchasing agent who possesses also the requisite information and purchasing skill is an invaluable aid in the securing of low costs; in fact, in most industries such a man is an absolute necessity.

3. *Stores and stock.*—In a continuous industry of an ideal type the material would be used as soon as received, flowing thru the factory without pause and going directly to the consumer as soon as fabricated.

Such conditions, however, are almost impossible to attain, tho closely approached in some of the simple continuous processes. In most industries the rate of sale varies with the kind of product and the season, and if prompt deliveries are to be made a stock of finished product must be carried on hand. On the other hand, materials must usually be bought in large lots in order that good prices may be obtained, and they must be bought in anticipation of production so that work may be started promptly. In shops making product to special order only, these features are not of such great relative importance; but even in these cases provision must be made for storing material in advance of fabrication and for storing the manufactured product until it is shipped. Stored material in any form represents inactive capital. The advantages of prompt service are supposed to more than compensate for the loss of interest, but this aspect of stored material should not be overlooked.

Raw or unworked material is properly known as stores, and the place where it is kept is called a storeroom. The function of the storeroom is to act as a reservoir, between the stream of incoming material and the production department, equalizing the variations in supply and demand. Finished product ready for the market is properly known as stock and the place where it is kept is called a stock room. The stock room acts as a reservoir between the production department and the selling department, equalizing the variations in the demand of the market and the

output of the factory. A careful distinction should be made, therefore, between the terms stock and stores, which are quite commonly used indiscriminately. In a small enterprise the stock room and the storeroom may be one room and under one man, but even here there are two distinct functions to be considered, and as plants increase in size a separation of these two functions becomes imperative.

Material which is being fabricated is known as goods in process. In addition to the raw material that is to be transformed into a marketable product, every factory, as explained in the foregoing discussion, must carry in its stores a considerable amount of indirect material; that is, material that does not enter directly into the product, but which is essential to its production. In works such as smelting furnaces and rolling mills, the amount of material carried in stores for repairing the usual wear and tear of the plant may be very great. Other supplies, such as coal and oil, must often be bought in quantity and stored, in order that the best market prices may be obtained.

4. *Finished-parts storeroom.*—In intermittent manufacturing it is often necessary to finish up a large number of parts of machines, or other products, and store them away, drawing them out as they may be needed for final assembly into a completed product. Thus it may be necessary to manufacture more parts than are needed for immediate consumption, in order to obtain the advantages of manufacturing in quan-

tity. Or again, certain parts that it requires a long time to produce, as compared to other parts of the complete machine, may be made in advance, in order to insure prompt deliveries of the finished product. A supply of such finished parts may also be carried to furnish repair parts for apparatus already sold. Stored parts of this kind are known as finished parts, and in some factories a special section of the storeroom is set aside for them and is known as a finished-parts storeroom. Such a storeroom acts as a reservoir to equalize the variations in the manufacturing processes of the factory.

In some factories where the parts manufactured are small in size but great in number, they are stored regularly between successive operations in order to permit inspection as to both quality and quantity. Such storerooms, however, are usually a part of the inspection system, and these parts, strictly speaking, are not finished parts till all work on them is completed and they are released from the custody of the factory foreman and deposited with the storekeeper.

5. *Administration of stocks and stores.*—The storeroom, therefore, may care for three classes of material, namely, stores, or raw material which is to be fabricated, and hence called also direct material; supplies, or indirect material; and finished parts of product ready to be assembled into completed product. In many cases all three classes of material are handled by the one department. But in large enterprises it may be an economy to organize separate departments

to handle each class. Thus, in large reduction works the ore which is to be reduced might be cared for by one stores system while the supplies necessary for repairs might be handled by a separate and distinct stores system. It will be noted that in large enterprises of this kind the item of supplies may be very large and the issuing of material should, in consequence, be carefully guarded.

In some enterprises which manufacture only a few kinds of product, but a large number of each kind, practically all parts may be stored in a finished-parts storeroom and drawn thence as required for assembly. The finished-parts storeroom then becomes of greater importance, and may be managed independently of the storeroom for raw material. This arrangement is sometimes found in factories producing machine tools.

Technically the stockroom should carry only completed products, but in many cases it may carry a large stock of finished parts in order to supply repair parts to customers. In such cases, however, the finished parts so stocked are treated as finished product, whereas their status in the storeroom is somewhat different, as will be seen. Obviously, the best method of administering the storerooms and stock rooms will depend on the character and size of the enterprise. In general, as industrial plants increase in size it becomes necessary to separate functions which can be managed collectively in a small enterprise.

The accountant and the cost keeper are interested,

therefore, in the following transactions in connection with the purchasing and the fabricating of materials:

(1) Purchasing of material
(2) Receiving, recording and storing of raw material
(3) Issuing of direct and indirect material to the production department
(4) Recording progress in manufacture
(5) Recording and storing finished parts
(6) Recording and storing complete finished product.

6. *Material requisitions.*—It is obvious that the character and quantity of the materials needed depend directly upon the needs of the enterprise, and cannot, in general, be specified by the purchasing agent, who is too often simply an expert buyer, tho, as previously noted, successful buying may require considerable technical knowledge. Where the material values are important, therefore, the purchasing should be conducted with great care. The material purchased for most enterprises is, as before explained, of two kinds, namely, material which is to go directly into product, or direct material, and supplies such as coal, oil, waste and the like, that do not go directly into product, yet are chargeable against production. The relative value of these two classes of material will depend on the industry. In some general manufacturing industries the indirect material may be a small

part of the purchases and the authority for requisitioning it may be delegated to the storekeeper, the summarized accounts of the indirect material purchased serving as a check upon the quantities used. In other industries, operating on a large scale on cheap direct material, the indirect material may be a very important item and the authority for issuing requisitions on the purchasing agent may be limited to more responsible officials.

In the case of a shop which does repair work principally, the material requisitions would most naturally originate with the foreman or superintendent, since, in general, he alone would know what is needed. Where the factory is building new work involving the making of drawings and engineering requisitions, the material requisitions would most naturally originate in the engineering department. In many other cases the order department originates the requisitions, basing them on the drawings and specifications, or similar information. Requisitions made out in the engineering department are, however, likely to be more accurate than those made in another department less familiar with constructive features of the work.

In a factory manufacturing standardized articles in continuous operations, the requisitions might emanate from the stores department, since this is the department charged with keeping the factory supplied with material. All requisitions for indirect material or supplies would also naturally originate in this department.

There are many shops where all of the three classes of work just outlined are carried on. In such cases, requisitions for the purchase of materials might properly originate from several sources. It is necessary, however, even in such factories, to see that this authority is centralized and that only reliable and intelligent officials are given authority to make out requisitions for the purchase of goods of any kind. Furthermore, no matter where the requisition may originate, it should pass thru the hands of the storekeeper so that he may use whatever material he may have on hand, or use up other material that may be substituted. Dead stores are, perhaps, the most unproductive form of capital investment; yet a casual examination of almost any large storeroom will show an amazing amount of this sort of material, much of which could be used up if proper care were exercised.

The particular form of the material requisition is not important, but whether issued by the foreman, or by the order department, it should, of course, bear all the information needed to identify the material with the work or purpose for which it is intended. If the order is for a particular job the requisition should give the job number, the time when the material will be needed and all other particulars regarding the physical and chemical characteristics which it must possess. In large enterprises the material requisitions are made in multiple, one copy being retained by the official issuing them, one going to the storekeeper and one going directly to the purchasing agent.

Copies may be sent to other officials, cases varying according to the exact system in use.

7. *Standard specifications.*—The material requisitions, whether for direct or indirect material, should be based on standard specifications if possible. Successful purchasing involves care in regard to quality as well as price. One kind of oil, for instance, may not be as good as another at the same price, for the purpose in mind. The purchasing agent should, therefore, be fully informed by those issuing the requisition, concerning the requirements for any desired article. When an accurate statement has once been made of the material required for any job, this description should be retained as a standard. In some cases the kind and quantity of material required is noted on the drawing itself and thus a permanent record is made; in other cases the material record is made on a specially prepared form, and carefully filed. Not only does this procedure assist accurate buying but it also makes possible accurate comparison of material costs on different shop orders, and allows the interpretation of comparative costs to be made much more intelligently.

Besides the service which the engineering department, or any similar planning department, can render in making up accurate material requisitions, it can also often save large sums by using standard material and material on hand instead of ordering special material. Special material, if not used for the purpose for which it was originally intended, is likely to

become obsolete, and in such a case a loss is incurred that might have been saved by careful planning. Such losses are chargeable to production costs. They increase, therefore, the burden, or shop expense, on every article manufactured, since, generally speaking, it is not possible to allocate these losses to the particular job on which the loss occurred.

Standardization of material and supplies should not be confined to the actual production of marketable goods, but should extend to every department of the business. The purchasing of office furniture and fixtures seems to be peculiarly susceptible to the vagaries of personality; the variety of desks, filing cabinets, and stationery to be seen in most large offices is certainly bewildering. Standardization makes possible the purchase of larger quantities of each class of articles, and thus insures lower prices and reduces not only the interest on permanent investment but also the number of items that go into the expense accounts.

8. *Purchase orders.*—The problem of obtaining the material specified by the requisition belongs to the routine of purchasing, with which this book is not particularly concerned. Certain requirements, however, must be included in this routine in order that accurate costs may be secured. The purchasing agent bases the purchase order on which the goods are bought, upon the material requisition. A typical purchase order is shown in Figure 6 (page 72). This order, besides giving the necessary information re-

BROWN MFG. CO.
BOSTON
PURCHASE ORDER

TO____________________ PURCHASE-ORDER NO.__________

ADDRESS____________________ PRODUCTION-ORDER NO. __________

PLEASE SHIP THE MATERIAL DESCRIBED BELOW REQUISITION NO.__________

PLACE OUR PURCHASE-ORDER NO. ON ALL INVOICES DATE __________

SEND DUPLICATE INVOICES AND BILL OF LADING

SHIP ON OR BEFORE	DESCRIPTION	QUANTITY	PRICE	

BROWN MFG. CO.
PER____________________

Figure 6

PURCHASE ANALYSIS

DATE		PURCHASE ORDER NO.		PURCHASED FROM	DESCRIPTION	MEMO OF PAYMENT		STOREROOM DR.		
						DATE	CHECK NO.	MATERIALS	SUPPLIES	
			1							
			2							
			3							
			40							
				TOTALS						

LEFT-HAND PAGE

PURCHASE ANALYSIS

WORK IN PROCESS. DR.			COMMERCIAL COSTS. DR.			OTHER ACCOUNTS. DR.			ITEMS IN SUSPENSE
ACCOUNT	MATERIAL	EXPENSE	ACCOUNT	MATERIAL	EXPENSE	ACCOUNT	MATERIAL	EXPENSE	

RIGHT-HAND PAGE

Figure 7

garding the material needed, will bear the requisition number and, if necessary, the production-order number of the job for which it is intended and will, in addition, be given a serial purchase-order number, as indicated in Figure 6. The purchase order will also bear a request to the merchant furnishing the material, to place the purchase-order number upon the invoice of the goods so that they may be identified, upon arrival, with the purpose for which they are intended. The purchase order will also bear full shipping instructions; sometimes a return receipt is attached, which the merchant from whom the goods are purchased may tear off, fill out, and mail as an acceptance of the order. A copy of the purchase order is sent to the receiving department so that the goods may be identified on arrival. The material ordered is thus identified with its purpose, whether it be for raw material, supplies or for some specific piece of work.

It should be carefully noted that, if this purpose is to be attained, oral orders must always be carefully confirmed by the regular purchase order. The promiscuous ordering of material by telephone, by those not authorized to do so, should be strictly prohibited.

9. *Receiving and inspecting materials.*—Provision should always be made to allow for the inspection of all material that is purchased. In small plants this may be accomplished by placing the receiving and inspecting in the hands of some particular person, but in larger plants a well-organized receiving department

is a prime necessity. Sometimes this department is directly under the purchasing agent; occasionally in medium-sized plants, shipping and receiving are combined. The best arrangement, however, makes the receiving department a part of the stores department, tho in very large enterprises it may be better to organize an independent receiving department.

When an invoice of material has been inspected, a receiving memorandum vouching for the details of inspection is made out by the receiving clerk and checked by other officials, so far as may be deemed necessary. Sometimes a copy of the purchase order itself is used for checking up invoices. This practice, however, is not to be recommended, experience showing that greater accuracy is obtained where the invoice is checked up independently and then compared with the purchase order. In either case the receiving clerk also places upon the memorandum the purchase-order number and the production, or shop-order number if the material has been ordered for a particular job, or the stores-order number if it has been ordered for general stores. He may also fill in any freight, cartage or other transportation charges and state whether they have been paid or not. Copies of the receiving memorandum are sent to the storekeeper, the purchasing agent, the accountant and as many others as are interested in the transaction, according to the system in use. The material having been thus identified, is taken to stores or directly to the production department, according to the circumstances.

10. *Purchase analysis.*—In some enterprises the purchased materials not only are of great variety, but they are used for many purposes, some of them going into stores first, some going directly to the factory and some passing to outside construction or directly to a customer. Furthermore, the number of invoices may be so great as to become burdensome if carried directly to the general books. In small factories the invoices themselves may be filed and indexed and the items posted directly from this file to the cost ledger or the general books, as may be desired. But in large and complex enterprises it is better to enter the details of invoices in a purchase-analysis book or purchase record, as it is sometimes called. A typical form for the page of such a book as might be used in a machine-manufacturing establishment is shown in Figure 7 (page 72). Each page may be devoted to the record of one kind of material; it will, in general, record the purchase-order number and perhaps the invoice number. It will record the date of the order, the name of the dealer and such descriptive detail as may seem necessary. In addition, it will be provided with columns for recording the distribution of the material. Thus, in Figure 7 provision is made for keeping a record of all material going to the storeroom, to work in process, to commercial costs directly, and to suspense accounts; there is also provision for debiting unclassified accounts. A space is left for recording payments that may be made on any invoice that is recorded. The detail to which this analysis is carried

will obviously vary with the business, but it is plain that such a record is conducive to a clear understanding of just how all incoming material should be charged and distributed to costs.

REVIEW

What are the qualifications of a purchasing agent?

What plan would you adopt for the organization of a purchasing department, and what would be the nature of the forms that you would employ for material requisitions and purchase orders? How does your scheme compare with that outlined in the Text?

What detailed standard specifications would you devise for some material with which you are familiar?

Can you rule from memory a form for a purchase order? for a purchase analysis? How do your forms compare with those used in the Text?

CHAPTER VI

STORING MATERIAL

1. *Storeroom methods.*—A good cost system is impossible without a good storeroom and good storeroom methods. Such a storeroom will have a place for everything, and everything will be in its place. All stores will be guarded against theft or unauthorized use as carefully as the cashier guards his cash. The writer is well aware that such detail is often considered a waste of time and money, and while it is true that there are isolated cases where the supplies are so few or so cheap that it will hardly pay to keep a storekeeper, it is also true that such cases are infrequent. It is a rare instance where a stores system will not pay good dividends.

The exact method of storing materials will, of course, vary with the industry and the class of material, but in any case all material should be stored in a convenient and accessible manner so that it is possible to draw it with the least possible difficulty, and also so that it is possible to take account of it with ease and dispatch. In the best systems each lot of material, or rather each bin or other receptacle, is numbered, or otherwise designated, so that material may be listed and found, or referred to, by list.

Where the works are large and several branch storerooms are in use, this system must necessarily be comprehensive. Thus the designation *6 A 24 h* might mean that certain material was stored in building No. *6*, division *A*, section *24* and bin or rack *h*.

All material ordered for an industrial enterprise may be classified as either standard material, special material, or supplies. Standard material includes such material as is used constantly in the product. In continuous industries this will be fairly constant in character, but the demand will vary with the activity of the enterprise. In intermittent industries this demand will vary not only with the activity of the enterprise but also with the changing character of the work conducted. Provision must therefore be made by the storeroom for anticipating the demands of the factory. The storeroom bins and racks in such cases may be likened to reservoirs for equalizing the supply and the demand. The amount in each bin or rack should therefore never fall below a certain minimum limit or exceed a certain maximum limit, these limits being fixed by the conditions of manufacturing.

The simplest method of insuring that a proper amount of each kind of material shall be on hand, when limits have been set, is by the method of observation of limits. A printed form is attached to each bin or rack, and on this form the limits are recorded. As material is drawn the storekeeper deducts the amount so drawn, thus keeping a continuous record of stock on hand. When the lower limit is

reached a requisition is placed for enough new material to bring the contents up to the maximum. By this means the wants of the factory are anticipated, and at the same time capital is not unduly tied up in idle material.

An objection to this method for large plants is the fact that the information regarding the state of the stores is widely scattered, and unless a classified index of the bin tickets is maintained it is difficult for the head storekeeper to check quickly the amount of any commodity. In addition to this disadvantage, the entries of additions and withdrawals, made on the bin tickets by storeroom attendants are, in general, more or less slovenly, and there is considerable liability of inaccurate entries, by either accident or design, with consequent errors in material costs.

2. *Stores ledger or continuous inventory.*—In more highly developed forms of material-recording systems all records are kept by the head storekeeper, or his clerk, either on a card system or on a loose-leaf ledger. Such a ledger has columns ruled to suit the special needs of the stores department, and is commonly called a stock ledger. The term stock, as before noted, refers more properly to finished product. The name stores ledger is more accurate when referring to raw material and will be used in this work, tho it does not conform to common usage. A typical page from such a ledger is shown in Figure 8 (page 80). The record of only one item is carried on each page and this record, it will be noted, includes not only all re-

STORES LEDGER

MAXIMUM ____________ FOR APPARATUS ____________ BUILDING ____________
MINIMUM ____________ DIVISION ____________
DRAWING NO. ____________ SECTION ____________
MATERIAL SPECIFICATION NO. ____________ SHELF ____________
BIN ____________

PURCHASED FROM	ORDERED			ASSIGNED		BALANCE AVAILABLE	INVOICE							ISSUES					IN STORES	
	DATE	REQ. NO.	QUANTITY	ORDER NO.	QUANTITY	QUANTITY	DATE	INVOICE NO.	REQ. NO.	QUANTITY	TOTAL REC'D	PRICE	COST	DATE	PRODUCT ORDER	QUAN-TITY	TOTAL	COST	QUANTITY	VALUE

FIGURE 8

ceipts and issues of the material recorded, but also all orders for new material and a record of any material on hand that has been assigned to work in process of manufacture. When a requisition from the production department is filled from the stores, it is canceled and sent to the head storekeeper, and no record is necessary at the bin or rack. These canceled requisitions in connection with the verified invoices of new goods give the storekeeper complete information regarding the condition of the material for which he is responsible, and if his department is properly conducted the stores ledger is a continuous or "perpetual" inventory of all material on hand in the stores. It is obvious that if this inventory is to be accurate the storerooms must be absolutely closed to all except the storekeeper and his assistants. No material may be delivered except on proper requisition, and any discrepancy between the stores ledger and the bin should be investigated and accounted for. These conditions hold also, for accurate results, with the bin-ticket system. Accuracy in accounting for material is essential to accurate cost finding. Provision is usually made on the stores-ledger sheets, as in Figure 8, for noting the price per pound or piece, and the total valuation, both for the purpose of inventory and for the purpose of correctly fixing the value of all goods issued from the stores.

The function of a stores ledger is, however, somewhat broader than simply to serve as a means of keeping track of material. If properly kept it enables the

manufacturer to carry the minimum amount of material and hence keep down his investment to the lowest economical point. A well-kept stores ledger greatly facilitates the care of the material and is a great check on wastes and losses due to carelessness, either in workmanship or in the handling of materials. Where the material handled is varied and valuable there is the same need for a stores ledger as there is for a cash book, tho, curiously enough, it is difficult to convince many hard-headed managers that this is a fact.

3. *Visual or "physical" inventories.*—It is still customary for many managers to take an inventory only once a year. Modern accounting methods demand, however, that an accurate record be kept of all changes in the value of the plant and the material. It is quite easy to keep a fairly accurate record of all changes in the plant and the equipment, but without good stores-ledger accounts not even an approximation can be made as to changes in inventories. With a good stores ledger, and a cost ledger which records the changes of material in process, a system which will be discussed later, a complete continuous inventory can be maintained, and the items in Figure 3 (page 27), which depend on material values, can be found at any time. It is a good policy, of course, to make an actual visual or "physical" inventory of the entire plant, occasionally, to verify these running inventories. A good storekeeper will constantly check up material on hand to see that no wastes are oc-

curring from theft, carelessness or error, and to make sure that his stores ledger is a true inventory of the goods for which he is responsible. Where good storeroom methods are maintained in connection with a stores ledger, the checking up of the material on hand may be made a continuous performance, and where this is done systematically the stores ledger can be made a very accurate record. This constant checking of bins and racks is useful, also, in that it brings to light periodically all dead stores, which are so common in most storerooms, and which not only represent idle capital but occupy valuable space in the storeroom or factory. A complete yearly visual inventory becomes, in such a case, simply a check on the accuracy of the stores ledger.

4. *Storing indirect and special material.*—Indirect materials or supplies are treated, so far as stores are concerned, in the same way as direct material. If the plant is large they may be kept in a separate storeroom, but this system is rather exceptional. The method of withdrawing such material for use and of charging up its cost is, of course, very different from the procedure in the case of direct material; it is more fully discussed in Section 8, Chapter VII.

Special material is ordered for some particular piece of work and is not ordinarily used in the manufacture of other products. It should, therefore, be ordered with care, only enough being obtained to satisfy the particular need, as it may depreciate in value very rapidly in the storeroom. Sometimes

special material is not put into the storeroom, but is sent directly to the place in the factory where it is needed, its value being charged to the proper account in the general books, or sent to the cost ledger, according to the system in use. If, however, the time of the arrival of special material does not coincide closely with the time at which it is needed, it should be stored in regular manner. It is bad policy to have material which is not wanted lying around the factory.

5. *Storing finished parts.*—In continuous-process industries of the extreme type, where the raw material is largely of the direct kind and flows thru the factory without pause, the functions of the storeroom may be confined largely to the care of supplies. But as the industry approaches more and more closely the strictly intermittent type, it becomes increasingly necessary to arrest the production of many parts at various stages of completion and store them in a partly finished state until they are needed. Thus, in making a line of engines it may be sufficient, for the needs of the business, to make the flywheels singly as needed; but it may be economy to cast and partly machine the engine beds in small lots; and, again, it may be desirable, both because of economy in manufacture, and also because of the possibility of quicker delivery of finished engines, to make up the small parts of the valve gear in fairly large lots. The financial and manufacturing economy underlying this practice is interesting and instructive, but it cannot be treated here; we must assume that the practice is correct.

FINISHED-PARTS LEDGER

NAME ____________________

DRAW. NO. ____________________

PAT. NO. ____________________

MATERIAL ____________________

MAXIMUM NO. ____________________

MINIMUM NO. ____________________

FOR APPARATUS
____
____
____
____

BUILDING ____________

DIVISION ____________

SECTION ____________

SHELF ____________

BIN ____________

ORDERED			RECEIVED			ISSUED				RESERVED		IN STOCK		UNIT COST	
ORDER NO.	DATE	NO. PCS.	ORDER NO.	DATE	NO. PCS.	ORDER NO.	DATE	TO SHOP	TO SALES	FOR ORDER NO.	NO. PCS.	DATE	NO. PCS.		

FIGURE 9

If the business is a very large one, as previously stated, a separate storeroom, known as a finished-parts storeroom, may be maintained, but usually the one storeroom cares for both raw material and finished parts. Sometimes a distinction is made between finished parts that are made in the shop, and purchased finished parts. This distinction, however, is of no importance, provided the cost of each part is accurately known.

Whether or not a separate storeroom is provided for finished parts, a careful and systematic record should be made of them, preferably on the continuous-inventory plan. Figure 9 (page 85) shows a typical finished-parts-ledger sheet similar to the stores-ledger sheet shown in Figure 8. The cost of the finished parts may or may not be entered on this sheet, since this cost will always be available on the cost-ledger sheets, which will be described hereafter. In some cases, however, it is convenient, in issuing these parts, to have the cost so noted.

REVIEW

How would you distinguish between purchased finished parts and manufactured finished parts?

If you were asked to furnish a form of ruling for a stores ledger and a finished-parts ledger, what would you submit, and how do your forms compare with those here suggested?

What are the important points to be noted in the devising of a stores department carrying three classes of stores?

What is special material, and what attention must be given to it?

CHAPTER VII

ISSUING AND EVALUATING MATERIAL

1. *Issuing materials in general.*—It is a cardinal principle in good cost-finding systems that no material of any kind should be issued from the stores without a requisition which indicates the authority for the transaction and the account to which the material is to be charged. It is true, of course, that in small shops, particularly where the material handled is of no value for personal use, it will not pay to employ a storekeeper; workmen may be allowed to help themselves from open bins or racks. As previously noted, these cases are rare; in general, it pays to have a storekeeper, whether detail costs are kept or not. He will, as a rule, save the company more than enough to pay his wages. It is universal experience that workmen when allowed to draw either direct or indirect material from the stores without check, become careless and wasteful, not only as to the quantity drawn out, but also as to its economical use. Loose storeroom methods are also likely to lead to dishonesty, pilfering and bad habits generally, on the part of employes. Aside from the actual saving made by properly regulating the withdrawal of material from stores, such regulations serve to accentuate constantly the value

of material, whether direct or indirect in character.

2. *Requisitions by foremen.*—The simplest way to arrange for the drawing of material on requisition is to empower the foreman to issue the required requisition. The foreman is provided with an order book, and no material is issued except on an order describing the material, its amount, and the purpose for which it is intended. This system is simple and flexible. It responds quickly to any emergency and for this reason it is particularly applicable in the case of small shops. There is no delay in getting material from the stores to the production floor, and in a shop doing repair work this is a valuable feature. In many small shops, where the work is more or less uncertain in character, the number of men employed is small, and refined cost-finding methods are not necessary, this simple system will answer all requirements. It certainly is a vast improvement over the loose methods so often employed in small shops, where every man helps himself and where no check whatever is put upon wastefulness.

If, however, the enterprise is large and each foreman has many men under him, it is not good policy to fill up his valuable time with clerical duties. He has usually too many other important functions to perform,[1] and if pressed for time, as he usually is, he will not do this requisitioning well. A busy foreman

[1] Mr. F. W. Taylor's paper on "Shop Management," particularly that part dealing with the many duties of the average foreman, in the "Transactions of the American Society of Mechanical Engineers," Vol. 24, deals with this subject in greater detail.

who is expected to maintain a large output from his department will not be particular or accurate in making out bills of material for marketable product; and if he is also obliged to write orders for supplies and indirect material, he will naturally be very inaccurate in regard to the distribution of the cost of these items. He can, of course, be given a clerk to help him in this work, and this assistance may answer in certain kinds of moderate-sized plants. From the standpoint of intelligent cost finding, however, even this method is unsatisfactory, and it fails for reasons that will follow. In fact, when the situation warrants the employment of clerical help of this character, it is time to discard a simple system for something more advanced and more accurate.

3. *Planning production in advance.*—Brief mention was made in Section 5, Chapter II, of the growing tendency to separate all planning functions from those that have to do with production. This is well illustrated in the engineering department, where all structural plans are made entirely aside from, and in advance of, actual production. A similar movement is making rapid progress in the production department proper, looking to the planning of all productive processes in advance of the actual productive operations. The writer uses the term production department to designate the entire productive organization under the superintendent of production, and not in the narrow sense in which it is often employed to designate what is really nothing more than a plan-

ning department. Planning departments are being introduced quite rapidly, and the growth of this idea should be studied by those interested in cost finding.

A planning department aims to do for the productive branch of the factory exactly what the engineering department has accomplished for the scientific branch. The engineering department predicts what is to be done; the planning department aims to predict how the work is to be done. The planning department is, of course, an integral part of the production department.

Obviously the *degree* to which it is possible to predict methods of production will depend on the character of the industry and the amount of study that has been put upon this phase of the particular industry under consideration. In general, the possibilities of predicting productive processes are not well developed as yet, but the tendency is in that direction and should be carefully studied in connection with cost-finding systems; for the general philosophy that underlies these movements holds true also for cost finding and is closely connected with its growth. The discussion, for the present, will be confined to the problem of finding costs as they accrue, but a later section will discuss the more advanced idea of predicting costs in advance of construction.

4. *Specifying the material.*—It should be noted in this connection, however, that if costs are to be determined intelligently, the methods of securing them must be planned in advance. Just as the designing

engineer should plan in advance all the constructive features of the product, and just as the superintendent of production should foresee all his productive processes, so the cost keeper should know in advance what costs he needs to collect and should lay his plans to collect them without, at the same time, gathering a mass of information he does not want. One of the most common and most drastic criticisms that is applied to many cost-finding systems is that they waste money in finding detail costs that are not useful, while neglecting, perhaps, cost data that are extremely valuable. It is for this reason, as before noted, that a good cost system cannot be installed in the abstract. It must be prepared with special reference to the particular business in which it is to be used.

In a well-organized modern factory of the intermittent type, therefore, the engineering department will turn over to the production department drawings and specifications which show just what is to be done. Each piece called for will bear an identifying number or symbol, as explained in Chapter IV. In best practice the engineering department will also furnish complete bills of material showing in detail just what direct material is needed for each part. Detailed statements such as these enable the order clerk, or whoever is charged with the duties of that office, to authorize with accuracy the withdrawal of material from the storeroom, and also, as will be seen, to identify the material with the costs of fabrication that belong to it. Where material lists are not made out

by the engineering department, bills of material are made out by the order clerk (Figure 2, page 21). Obviously, the more accurately these material lists are compiled, the more accurately can the raw material be drawn from the storeroom.

5. *Production orders.*—The order clerk can now

PRODUCTION ORDER

TO DEPT.________________ ORDER NO._________

DATE OF ISSUE______________ DRAWING NO.________

TO BE COMPLETED BY _______ PATTERN NO.________

DELIVER TO DEPT. __________ SPECIFICATION NO.___

CLASS NO.__________

PLEASE EXECUTE THE FOLLOWING ORDER RETURNING THIS SLIP TO STOREKEEPER ON COMPLETION OF WORK
CHARGE ALL LABOR AND MATERIAL TO THE ABOVE PRODUCTION ORDER NO.

DESCRIPTION OF ORDER

QUANTITY AND DESCRIPTION OF MATERIAL TO BE USED		DATE NEEDED	DEPT.

DATE ORDER COMPLETED_________________________________APPROVED_________________________

FIGURE 10

issue a production order, as illustrated in Figure 10, above, to the foreman under whom the work is to be done. If the amount of material to be drawn is comparatively small, this production order may also be, for convenience, the material list, as illustrated by Figure 10. This is not an essential point, however, since the material list may be on a separate sheet, or may be a permanent record, made on the drawing it-

self. The production order will, in general, give all necessary information regarding time of completion and the disposition of the part when finished. This order will also bear the specification number or the drawing number of the part referred to, and the production-order number to which the cost of the production is to be charged. Thus the part is identified with the time cards recording the details of its production, which are to be returned from the factory.

Clearly, the issuing of production orders requires not only an intelligent understanding of the costs that are desired, but also a thoro comprehension of the manufacturing problems concerned. A single production order might be made to cover a battleship, or a separate order might be issued for every individual part going into this same ship. On the one hand, it may be of great importance to know with accuracy the cost of one line of goods in which competition is very keen, whereas, on the other hand, in some other line, where the margin of profit is very high, it may not pay to obtain very accurate costs.

The detail in which it is necessary to know the cost of the several parts of a machine will vary with the machine and with the conditions, and the grouping of the several parts under production-order numbers requires good judgment. Furthermore, if best results are to be obtained, the order clerk must keep in mind the uses that are to be made of the cost data after they have served to determine the costs of production. If these data are to be used as a basis for

managerial reports of a comparative nature, this fact may somewhat influence the issuance of the production orders. Obviously, also, if segregated expense accounts such as are listed in Section 1, Chapter IV, are to be maintained, all expense material must be drawn from stores in such a manner that it will be accurately accounted for. It requires a high-grade man to place production orders so as to get the results desired and yet not waste money on details that are not necessary.

6. *Instructions to storekeeper.*—The production-order and material lists are usually made in multiple, one copy going to the foreman concerned, with all drawings and specifications connected with the work, and constituting his permanent authority for doing the work. Another copy goes to the storekeeper; it is his authority for issuing the material when it is demanded by the foreman. A copy is, of course, retained by the order clerk. The storekeeper or his assistant issues the material called for, cancels his copy and corrects his record of material on hand, either at the bin, or on the stores ledger, if one is kept. If a stores ledger is kept the record of the transaction may be recorded under "issues" as indicated in Figure 8 (page 80). The production order can then be evaluated, the price per pound or piece being filled in, and it can be forwarded to the cost department to be incorporated into the cost of the part to which the particular production number belongs. A similar procedure could be followed with the simpler form

of requisition issued by the foreman, but the accuracy of the material list as made by a busy foreman is greatly to be doubted.

Theoretically, this method is very accurate. In practice, however, it is difficult to specify with absolute exactness every item of direct material needed; but, except in the case of very complex work, the errors need not be serious. The chance of error is more than compensated for by the manner in which the method prevents unnecessary withdrawal of direct material, and fixes the proper authority and responsibility for withdrawal in such a manner that errors and irregularities can be instantly traced to those responsible.

7. *Emergency requisitions.*—A great objection often made to such a system is that it is not flexible under emergencies, and that small jobs always cost more when passed thru such a system than they would if managed by a simpler one. For example, when a serious breakdown in the machinery of production occurs there is little time to make bills of material and to write requisitions for them; and when repairs are being made while the factory is temporarily idle, a rigid requisition system may be embarrassing and may greatly hamper the progress of the work. Again, in making commercial repairs it may not pay to make drawings, or even sketches, and write out bills of material based upon them; moreover, when this procedure is carried out the cost of such repairs may be excessive.

These defects can be partly obviated, however, by empowering some official to issue emergency requisitions to take care of these special cases. In such instances the official possessing this emergency authority would issue the material requisitions that are needed, and have proper production orders assigned as soon as possible thereafter. Provision must always be made for caring for emergencies in any system, or its inflexibility may destroy its usefulness. Many good cost systems and other systems have failed on this account. Some, in fact, have been unable to obtain even a good foothold in shops where they were being introduced, largely because impatient foremen or superintendents, who are being hard pressed for production, fear that a new system will destroy flexibility, even tho, perhaps, it improves other manufacturing conditions.

The foregoing discussion has reference largely to manufacturing enterprises of the intermittent type, tho the principles are general and apply to many other forms of industry. As the enterprise approaches more closely the other extreme, or continuous operation, the necessity of detail becomes less and less, until finally no production order for direct material may be needed, since all material will be purchased in large quantities and its value will be carried directly to the general books.

8. *Requisitioning indirect material.*—Indirect material, such as coal, waste, oil, brooms, and the like, is not handled by production order. Usually this

class of material is drawn on the foreman's requisition. It is still customary in many factories to have the foreman assign the order number to which the supplies drawn are to be charged, this number being, in general, the production-order number on which the workman is at the time employed. As will be explained later (see Section 5, Chapter IX), such supplies should be charged to standing-order numbers, if intelligent costs are to be obtained, and distributed by one of the methods to be discussed. The storekeeper evaluates the foreman's requisition for indirect material and sends it to the cost department. It should be noted in passing that where supplies are drawn in very small quantities it is difficult in some cases to keep an exact record. Thus it would be difficult to keep an accurate record of lubricating oil; supplies of this kind are often charged in a lump to the proper expense order. But even in such cases it is a useful check on waste to issue the supplies only on a requisition.

9. *Valuation of issued material.*—The value of material stored in the bins of the storeroom is necessarily somewhat greater than the market value of similar material. Freight, cartage, the handling of the material in storing it, rent, or interest on the building investment, insurance, wages of storekeepers, waste, shrinkage in use, as by saw-cuts and remnants, defective pieces, repairs and other storeroom expenses, are all necessary expenditures which must be paid in order to obtain the advantages of having material

ready for immediate use. This expense should never be overlooked in evaluating the material issued from the stores, particularly if material should be shipped directly to a customer from the storeroom, as is done in mercantile establishments. Unless the billing price of such goods is an advance on the market price paid for them, it is evident that a loss will be incurred. In fact, it is sometimes more profitable for a factory to order standard material to be sent directly from dealer to customer than it would be to fill the order from the storeroom bins.

Furthermore, material is crystallized capital which is earning no interest. It is perfectly proper, therefore, to charge against it the interest that it should earn; and this, again, adds to its value. Materials also may depreciate in value while stored, and while this loss in value is a proper charge against production it is usually more convenient to handle it in a manner separate from those methods now to be discussed.

In the simpler and merely approximate methods of cost finding, all storeroom expenses are carried to the factory-expense account and charged off as part of this expense. While this insures that the total of such expense is cared for, it does not distribute it logically, and more modern methods of cost finding distribute storeroom expense as a percentage on the value of the material issued. This, as will be seen later, is in accord with modern tendencies, which aim to allocate all expenses, as far as possible, to the par-

ticular activity to which they peculiarly belong. The value of issued material should, therefore, be determined by adding freight and cartage to the invoice price of the goods and then adding a percentage to cover storeroom expenses.

Now, the invoice price of the same goods changes constantly with the changing market price. The material in a given bin may have cost more, or less, than a new lot which has just been added. To equalize this difference in prices, the total value of the entire lot may be divided by the total combined number of pieces or pounds and a new average rate determined which will equalize the market fluctuations.

10. *Value of material in process of fabrication.*—It will be noted that the foregoing storeroom methods do not take cognizance of materials that are in process of fabrication. Modern accounting methods, however, often require regular and frequent statements of the financial conditions of the enterprise. If the latter is of the continuous type, where the value of the material in process, at any time, is not great, the methods described above may be adequate for all purposes. In many cases, however, the value of the material in process is very great and no correct statement of the business can be rendered without taking it into account.

It is obvious that it would be well-nigh impossible to keep account of the cost of the material in process by simply adding to its value the value of the material drawn from stores, and subtracting the value of the

material delivered to the stores or the shipping room. For this reason, even in factories where some lines of product are in continuous production, it is customary to pass the product thru the factory in lots, a production order being issued for each lot. If a cost ledger is kept, an account would be opened for each lot under its own production number, and all material which went into the lot would naturally find its way to this account and could be evaluated at any time. The total value of all material appearing in the cost ledger is the value of all material in process.

11. *Value of finished parts.*—So far as the production department is concerned, finished parts manufactured for stores do not differ from other products, and they should bear their full share of all indirect expense. This should be kept in mind in evaluating such parts, since factory expense is an integral part of shop cost. Thus, one manufacturer might buy from another manufacturer some finished parts, such as gears, for instance, storing them in his regular storeroom, and issuing them to the factory at the cost price plus the cost of handling them in the storeroom. Or he might make these gears himself, keeping account of all labor, material and indirect expense involved in their production, and then deposit them in his finished-parts storeroom, assigning to them the value thus determined.

In issuing such manufactured finished parts to customers for repairs, they would, of course, be charged with their proper share of general expense and with

an allowance for profit, just as in the case of any other finished product. In issuing them to the production department to be used in assembling complete machines they would be treated like any other material or finished parts that have been bought elsewhere. Care must be exercised, however, to see that expense charges are not duplicated. Thus, if the material value is used as the basis in distributing the expense it would not be logical to charge the expense on this basis when putting the finished parts into the storeroom, and then to duplicate this procedure when the parts are assembled into finished machines. The best method of distributing the expense on finished parts will be clearer after a discussion of the methods by which such distribution is accomplished. This matter is treated fully in Chapter XIII.

12. *Tracing progress of work.*—Where the products of the factory are varied, and where many finished parts are made for the stores, it is often very important to ascertain the state of fabrication in the case of all production orders. Thus if the supply of a certain kind of finished parts were low, and a large number were just nearing completion and were about to be delivered to the stores by the production department, it would not be good manufacturing policy to place a rush order for a large number of these parts. To obviate the difficulty involved a stock-tracing ledger, so-called, is sometimes employed. This ledger is usually of the loose-leaf type or else it is a card system; a single leaf or card

is used to record the movements of one lot of material from the time it leaves the storeroom until it is delivered as finished parts. This record is in reality a continuous-progress report of the particular lot of material the movements of which it records as it passes thru the factory. In simple systems these ledger sheets may also record the cost of the material as well as the labor accruing on it, thus combining the functions of a cost ledger with those of a stock-tracing ledger. In general, however, it will undoubtedly be better to keep these two functions separate, using a cost ledger only for financial summaries of costs.

Stock tracing, so-called, grew out of a logical need of knowing the progress of all jobs and of insuring that required deliveries would be met. From stock-tracing have grown more advanced systems, which should be noted, since they tend to change cost-finding methods.

13. *Routing and scheduling.*—The stock-tracing ledger and the stock-tracing methods just discussed record the progress of the material thru the several processes. It will be noted that the entries are made on the ledger after successive operations have been performed. Under more advanced methods of factory administration, the previous planning of productive processes and the scheduling of all movements of material and of time operations, are becoming important features. Such methods aim not only to plan in advance the route or sequence of machines and processes that the material is to follow but also,

often, to fix the time that shall be consumed by each operation. In some very advanced schemes of this character, this analysis of procedure and the scheduling of the time element are made in great detail. Clearly, if the time element can be predicted the cost can also be predicted; as a matter of fact, there is a decided tendency to attempt to do this, even where advanced methods of administration have not been installed. Such ideas not only tend to affect cost-finding methods but, as will be seen, they strongly influence the methods of rewarding labor.

Even a brief discussion of these stock-dispatching methods is beyond the scope of this book, but the accountant who is installing a cost-keeping system will do well to inform himself regarding them, since they are so closely related to cost-finding methods. Aside from the question of any direct assistance which these methods may render in finding costs, their indirect effects upon the reduction or increase of costs are of great importance. The introduction of such methods and systems may be justifiable even tho they do not reduce prime cost. Thus, if they succeed in increasing the rate of production without changing the prime cost of production, an increase in profits is made possible. Again, if the time of delivery of product can be hastened and made more certain a gain may be accomplished for which the factory can afford to pay something; but none of these results should be taken for granted, and each and every item of this kind should be judged with the

financial facts in hand, and not in the light merely of superficial evidence or personal opinion. The extent to which these advanced methods of administration may come into use is not at present very clear; nevertheless, as has been noted, they should be carefully considered by students of cost-finding methods.

14. *Value of finished product and stock.*—When a product is made to order it is usually shipped to the customer when completed, the factory cost is summarized from the cost ledger or corresponding record, the necessary additions for general expense, selling expense, and profit are added and the transaction is closed except for the collection of payment. Where the product is made in anticipation of the market, and especially where production necessarily is in large lots, the finished product must be held in storage till sold. A large factory may have not only a large stock of finished goods in the central stockroom at the factory, but also branch offices which carry such finished product. The amount of money so tied up may be very great.

The general and selling expenses are usually distributed over the product as a percentage on the factory cost. It is no longer necessary to keep the labor and material components of cost separated. The cost-ledger account may therefore be closed, and the finished product may be listed on the stock records at factory cost. The methods of distributing general and selling expenses will be discussed in a later section.

It should be carefully noted that the factory cost

placed upon the product when it is deposited in the storeroom is not necessarily the permanent value of the article in question. The factory cost represents the investment in labor and material up to this point and, like any other investment, it may change in value. Theoretically, if the article should lie in the storeroom for a year, its *actual cost* to the factory management would be increased by the interest on the investment and the cost of storage. Practically, however, most product begins to deteriorate from the moment of its production, either from the action of the elements or because of progress or change in the methods by which the product is manufactured. A full discussion of this phase of material values may be found in Chapter XII.

15. *Finished-stock record.*—Just as it is necessary to have accurate records of raw materials and finished parts, so it is necessary to have accurate records of all stock. Such records not only guide in placing production orders, but, if properly studied, they will prevent the accumulation of obsolete stock. Records of this kind are usually kept on loose-leaf ledgers such as are illustrated in Figure 11 (page 106). A leaf devoted to each item of stock shows all receipts from the factory, all shipments and the balance on hand. The dates of all receipts and all shipments are also recorded. This is important for two reasons: first, to show the rate of shipment so as to gauge the desired rate of production; and second, to serve as an aid in judging depreciated values when inventory is

taken. This last is highly important in a business which is developing rapidly. Thus, a few years ago electrical apparatus held in stock became obsolete in a short time because of the progress of the art. As this obsolescence occurs in the case of most manufactured goods, the stock record is of great value in guarding against such loss.

STOCK LEDGER

MAXIMUM ________________ BUILDING ________
MINIMUM ________________ SECTION ________
ARTICLE ________________ SHELF ________
CLASS OR NO. ________________ BIN ________

DATE		PRODUCTION			SHIPMENTS			BALANCE		
		QUANTITY	RATE	AMOUNT	QUANTITY	RATE	AMOUNT	QUANTITY	RATE	AMOUNT

Figure 11

The stock record gives the location of the apparatus which it records, the maximum and the minimum amount to be carried, and also a column for its evaluation. The stores ledger, the active accounts in the cost ledger, and the stock ledger already discussed, constitute a continuous inventory, and from them can be obtained at any time the value of all material grouped in the three important stages of fabrication,

namely, as raw material, material in process and finished product.

16. *Material wastes.*—A most important feature of the care and accounting of materials is the matter of waste. Every factory has its own peculiar sources of waste. These should be carefully located and their effect minimized as far as possible. Wastes are of two general kinds; they may be classified as avoidable and unavoidable wastes. Those due to carelessness in handling or overissuing material are what may be called avoidable wastes, as are also losses by pilfering, or from the diverting of material from the factory in any way without compensation. A well-kept stores ledger and a careful periodical checking up of material on hand will minimize losses of this kind. If more material is issued than is actually needed for the work in hand serious loss is sure to occur. Material left over from productive work is not likely to be returned to stores unless a special effort is made to bring this about. Ordinarily it will lie around the shop in boxes and under benches, and much of it will find its way into irrecoverable scrap. Material requisitions should, therefore, be drawn with care to minimize this form of loss, and any material left over from a given job should be carefully returned to stores and credited to the work for which it was originally requisitioned.

Unavoidable wastes are such wastes as are incurred in cutting up material. Thus the waste due to cutting up copper bars, either by saw cuts or under presses,

may be considerable. Even with cheaper material, as, for instance, sheet steel, where large quantities are used, the value of the scrap may be great. If the waste is in such form that it may be returned to stores and used for other purposes, the job in question may be credited with the value of the scrap incident to its production. In fact, in some cases if this procedure is not followed the material cost will be prohibitive. But in any case all scrap and waste should be carefully noted and, if salable, it should be gathered up and stored, pending such sale. Not the least important feature in the handling of material is to impress on foremen and workmen the fact that material represents money and should be treated accordingly.

It will be clear that the value of all material purchased, as recorded in the general ledger account, may, and generally will, exceed the value of the same material as charged to production, in the cost ledger, by the amount of waste and similar losses. In some kinds of manufacturing such differences are difficult to check up; but wherever it is possible this should be done periodically. If there are any returns from the sale of scrap this should, of course, be taken into account in considering the difference between the summaries from the two sources. A similar discrepancy may exist between the time paid for on the payroll and the time charged by the cost system against the same piece of production. It is generally easier, however, to minimize this difference in the case of labor than it is in the case of materials.

REVIEW

Rule from memory a form of production order. How does your ruling compare with that of the text?

What are the movements of the production order, from its origin to its final destination?

What are the usual causes of discrepancy between the physical inventories and the book inventories? What steps would you take to reduce the discrepancies?

Why is it important to trace the progress of work thru the plant?

On what basis would you distribute storeroom expense?

How should valuation be made of issued material? of finished parts?

CHAPTER VIII

COST OF LABOR—WAGE SYSTEMS

1. *Labor in general.*—It has been shown that the material entering into a given article can in most instances be ascertained in advance. Bills of material can be made out, material can be measured, weighed or counted, and the value entering into a given part can be recorded with sufficient accuracy. Labor costs, however, present a somewhat different problem. The amount and value of the material going into a given part will, in general, be fairly constant, but the value of the labor bestowed upon the same operation at different times in the manufacture of similar part may vary within wide limits unless measures are employed to prevent such variation. Labor is usually the largest item entering into factory costs and since, also, the direct labor is often used as a means of measuring the factory expense which belongs to each part, it is evident that labor costs should be accurately determined if possible.

In industries employing large and expensive machinery, labor costs are doubly important. So far as actual wages are concerned it might make little difference whether a workman were paid $3.00 or

$4.00 a day; but if the difference in wages is a measure of relative efficiency, and if this difference is reflected many-fold in the product of a large and costly machine, the difference in output might be very marked. It is, therefore, highly important that careful records be kept which shall enable the manager to tell as closely as possible the labor costs of all operations performed. Even where accurate detail labor costs are not obtainable it is good policy to make a record of all time expended, if for no other reason than to impress the workman continually with the value of time. There is seldom much difficulty in obtaining and recording the time bestowed upon any given part, but to find out whether or not this recorded time is a just amount is not an easy matter.

For the manufacturer pressed by competition, there are, apparently, only two ways of reducing costs. One is by reducing wages; the other is by developing better methods. But low wages do not necessarily mean low costs, since labor is not as yet such a closely definable quantity as material. In fact, the latest philosophy of industrial administration tends to indicate that low labor costs and cheap output, far from being synonymous, may be diametrically opposed, and that low productive costs can often be obtained only by incurring high labor costs. At least, high labor costs and low productive costs are not necessarily antagonistic. A comprehensive discussion of wage systems is, of course, outside the scope of this discussion, but it is necessary at least to show the na-

ture and influence of wage systems first, because this will indicate the problems met in actually recording labor; and, second, because this will also indicate certain tendencies in modern methods which will undoubtedly have a marked effect on cost finding and cost-finding methods.

2. *Two primary methods of rewarding labor.*—There are two, and only two, primary methods of paying for work. One is to pay the workman for the amount of time which he spends on the work, at an agreed rate per unit of time; and the other is to pay for the amount of work which he performs at an agreed rate per piece. The first method is called daywork, because formerly the most usual time unit paid for was one day. The other is known as piecework, since payment is made by the piece. All other schemes for compensating labor are combinations, of one kind or another, of these two primary methods. These two principles, and the difference between them, should be carefully noted. Some of the advanced wage systems now in use have a complex appearance and would seem, at first sight, to rest upon deeper reasoning. But careful analysis will show that, in all cases, these principles alone lie at their root. It should be remembered, also, that the basic rates of any and all wage systems are fixed, in the last analysis, by competition.

3. *Daywork.*—The daywork method of rewarding labor is the older method, and the reason for its original use is not difficult to discover. In the beginning

of any industry the duties of the laborer are general, and not special. In former days and under simpler methods, where the attitude of the employer was essentially paternal, the daywork system was the most convenient and the most natural one. The relation of the employer and the employe was quite personal and the employer depended on the loyalty of his workmen to obtain value received for the wages paid. Where the number of men is small and the work will allow of close personal supervision this system is still effective. It is even now in general use and will no doubt continue in use even where other systems would be better, simply because it is less involved than the piecework system. In large organizations the higher officials are still paid on a time basis, tho other methods may have been adopted in the factory. Where close supervision is not possible, as in outside erection work, day pay is usually the only workable method, but care must be exercised in selecting reliable men.

The unit of time for which pay is rendered varies with the grade of the employe; the higher the grade, the longer, as a rule, is this unit. Thus managers, treasurers and other high officials are usually hired by the year, or for a term of years, and are paid by the month. Foremen, engineers, and the like, are hired and paid by the month. Other classes of labor are usually paid by the hour, usually no fraction less than one-half hour being considered. The philosophy of the system is well illustrated in the foregoing classi-

fication. The method cannot be depended upon to insure value received unless the employe is loyal and free to put forth his best efforts. Evidently, the only factors needed in recording labor costs under this system are the hours of work and the rate agreed upon.

It should be noted, however, that in general, under this method of pay, cost finding is entirely a matter of recording costs after they have been incurred. Every employe is expected to do his best, and it is the duty of foremen and others to see that he does so. But there is no guarantee that each man will do his best, and it is not logical to expect that under this system, labor costs on the same article made at different times, even by the same men, would be the same. Labor costs, under the daywork system of pay, may therefore be expected to vary widely.

4. *Piecework.*—As factories became larger and the personal relations between employer and employe began to vanish, the defects of the daywork method became more and more apparent, especially when conditions were complicated by the growing influence of labor organizations. Workmen, feeling intuitively that they could influence the law of supply and demand by limiting production, did not work up to their capacity. The amount of output tended constantly toward a minimum, the old conditions under which men could be driven to produce a greater output having already passed away. The employer, furthermore, did not, and for that matter does not as yet, really know what constitutes a fair day's

work, and in his dilemma naturally looked around for some other method of insuring returns. Thus the piece-rate method came into prominence.

This system, while not new, has not been much used until comparatively recent times. Under this method the employer pays for the work by the piece, irrespective of the time expended. If the employe makes more pieces his total wage rises in proportion. If he makes fewer, his wages decrease in like proportion. If the piece rate is a fair one to both parties, this method would seem to be ideal for all concerned, provided the work is of such a character that piece rates can be set intelligently.

Under this system of pay, the labor cost may be predicted and cost finding under this method would seem to be simpler than under the daywork plan. Furthermore, the cost of the same article should be the same, no matter what man did the work, and any variation from time to time would be known and would not be merely a matter of conjecture. This feature of piecework, no doubt, appeals strongly to the manufacturer.

5. *Disadvantages of piecework.*—The difficulty with piecework arose, however, from the lack of knowledge of just what a fair piece rate should be. No systematic study had been made of this matter, and when men were transferred from daywork to piecework, they easily made very large earnings. This, in turn, tempted the employer, either from cupidity or because he really believed the employe

was getting more than a fair share of returns, to reduce the rate, the cut in rate being repeated, perhaps, several times until the discouraged worker found himself working much harder than formerly for only a small advance in income. Piecework has, as a consequence, come into bad repute in many places.

In the recording of piecework costs it would seem that all that is needed is the number of pieces made and the rates per piece. But even when the actual time consumed is not a factor in the cost, it is an essential requirement in factory management that all men work regularly and turn out a sufficient quantity per day. Profits depend not only on the gain per piece, but also on the number of pieces made. A low nominal piece rate may result in a high actual cost if the quantity produced is too small. Provision must therefore be made for checking up the regularity with which pieceworkers come and go in the factory.

It was to be expected that the growth of manufacturing methods would bring with it new plans of rewarding labor, if for no other reason than that it meant the disappearance of personal relations in large enterprises. The large operator of today is very unlikely to consider labor as a personal matter between the worker and himself, but is apt to look upon labor as something to be purchased like any other commodity. Men speak of buying labor instead of hiring men. This tendency is greatly to be deplored, for labor is essentially personal, and because of the personal relations involved it is difficult to

measure it abstractly, as one would measure material. It is no wonder, therefore, that under modern complex manufacturing conditions, with minute division of labor, and the complex social and labor organizations resulting therefrom, these older systems of rewarding labor have been found inadequate. They are still, it is true, in general use and will continue in use wherever conditions are such as to render them satisfactory; but beyond doubt other methods are rapidly coming into use, particularly in the more complex situations.

6. *Halsey's premium plan.*—The first of the new methods was that evolved by Mr. F. A. Halsey, and known as the Halsey premium plan.[1] Under this method, the worker is assured a definite day's pay if he reaches a certain production. If he exceeds this production he earns a premium in addition to his regular pay. To illustrate, suppose a certain piece of work requires ten hours, normally, for its completion and the workman's pay is $3.00 for ten hours. Suppose, further, that it is agreed that the workman shall receive one-third of his hourly wage, extra, for every hour by which he can shorten this standard time. Suppose, again, that he does the work in nine hours. Then the premium will be $\frac{1 \times 30}{3} = 10$ cents, and his earnings for the nine hours will be $(9 \times 30) +$

[1] It appears that premium systems of wage payment had been in use in England many years ago. No doubt, the idea is old, but so far as modern factory work is concerned Mr. Halsey is entitled to the credit of its introduction.

10 = $2.80, or at the rate of $3.11 per day. Should he fail to reduce the time, or, in fact, should he exceed the ten hours set as a standard, he would still receive $3.00 per day, provided, of course, that he was not so slow as to be an undesirable worker.

The Halsey plan, therefore, recognizes the principle of increased pay for increased effort, which is the basic principle of piecework, but the proportionate return for increased effort is not so great as under the method of straight piecework. On the other hand, this defect is compensated for by the protection of the workman against being penalized should he fail to attain the standard performance. It is clear also that special provision must be made under this system for reporting the times of operations and the premiums earned. It is equally clear that under this method of pay the labor cost of a given piece may vary between wide limits. The conciliatory nature of the Halsey plan has brought it into extended use, and it has exercised a great influence in the formation of other kinds of wage systems.

7. *Taylor system.*—The standards of performance for the Halsey plan were based originally on such records of previous performances as were at hand, or, these being lacking, upon the personal judgment of some official. In all of the systems discussed so far, no effort is made to find out with accuracy what really constitutes a fair basis for a day's work, and all of them depend on enlisting the interest of the workman thru increased compensation. In 1895, in a

remarkable paper before the American Society of Mechanical Engineers, Mr. F. W. Taylor pointed out that it was possible, by studying the details of any operation, to determine a minimum time in which each operation could be performed, and that on the basis of these detailed observations it was possible to fix the minimum time required for the job or similar jobs. He pointed out, also, that by surrounding the workman with the best conditions and with expert advisers it is possible to reach the standards predicted by these experts. To encourage the worker to reach a given standard Mr. Taylor established two piece rates, one a very high rate for those who reached or exceeded the standard, and the other a very low rate to penalize those who did not attain the standard. Because of the penalizing feature, it has been difficult to operate this pay system, but the theory of studying operations in advance, with the object of fixing a fair day's rate, has become an accepted principle in factory management.

There is no new principle involved in Mr. Taylor's piece-rate method, and it was not uncommon, long before he presented his paper, to make rough time-studies of operations. The idea of making minute and accurate time-studies was new, however, and it has opened up large possibilities in the matter of predicting times of operations, and determining costs in advance. Of course, the cost of clerical help in making so-called time-studies is a charge against production that must be compensated for by increased pro-

duction. Within limits, however, the extra expense can be more than overcome and the profits can be increased by this method.

8. *Gantt task-and-bonus plan.*—With a view to combining all the good features of the previous methods, Mr. H. L. Gantt introduced what has become known as the task-and-bonus plan. Under this scheme the workman is assured his day rate as under the Halsey plan. A careful study is made of the work and conditions, to determine just what a good performance should be, and a definite task is assigned to the workman. If he equals or exceeds this standard record he is given a bonus in the form of an extra time-allowance. The plan in effect gives day pay if the task is not performed and piecework pay if the bonus is earned. Mr. Gantt lays great stress on the importance of training men to enable them to earn the bonus, thus utilizing labor as he finds it and not excluding the mediocre man who, in the beginning, might not be able to make a bonus, but who may easily do so under proper instruction. The methods of securing records of labor costs under this system must take cognizance, therefore, of several factors, and special provision must be made for getting such records.

9. *Emerson system.*—The system introduced by Harrington Emerson assures the workman of his day's pay as does the Halsey plan. Like Taylor and Gantt, Emerson makes a careful study of the work and establishes a standard performance. A large

bonus is given the workman if he attains this standard performance, but smaller bonuses may be earned before he reaches it, very much as in the Halsey plan, so that the worker's wages vary with his efforts. No bonus is paid, however, until the worker has raised his output to two-thirds of the standard, or, as Emerson expresses it, until his "efficiency" is $66\frac{2}{3}$ per cent.

Thus, if the time set for a certain piece of work is 120 hours, and the worker performs the task in this time his "efficiency" is one hundred per cent, and he receives a bonus of twenty cents for every dollar of day-rate wages to which he is entitled. Should he do the work in one hundred hours his efficiency is 120 per cent, and his bonus is forty cents for every dollar of wages. While should he take 160 hours for the work his efficiency is seventy-five per cent and his bonus is only fifteen cents per dollar of wages.

10. *Résumé of wage systems.*—In all of these advanced methods of rewarding labor, where a bonus is given for the performance of a definite task, it is the expectation that the task set is about what the workman should and can do. In the best types of advanced management, also, the workman is given every possible aid that will assist him to accomplish the task and earn the bonus. If this can be done, the labor costs, under these methods, should not vary greatly, tho at first sight this would not seem to be the case.

These new methods of time-study and the predic-

tion of manufacturing performances should be carefully noted. Such predictions are, in general, difficult because of the elusive character of the labor element; and recorded costs, while presenting accurate records of what has been done, are not necessarily a criterion of what can be done. These new pay systems, furthermore, involve more than changes in the actual methods of rewarding labor. They involve changes in management, and if managers are to predict performances and costs, and there is no doubt that they will, an accurate cost system that will give them the necessary information for so doing will be an absolute necessity.

The new methods of finding these costs may, however, be somewhat different from those in common use at present, which are based on the idea of recording costs as they are found rather than as they should be.

REVIEW

What are the fundamental differences between the daywork and piecework systems of wage payment?

What is the importance of insuring that all men shall work regularly, even when paid by the piece?

What difference do you find from a comparison of the Halsey, Gantt, Taylor and Emerson systems of wage payment? How does your analysis of these systems compare with that in the text?

Which of the systems of wage payment do you prefer, and why?

How would you overcome the objections of workmen to the installation of a bonus system?

CHAPTER IX

COST OF LABOR—RECORDS

1. *Recording time by checkboard.*—No matter what wage system is in use in the factory, it is usually desirable to record the time at which every employe enters and leaves the works. In very small plants the foreman is usually depended upon to enforce regularity, but the limitations to this method are obvious. In larger plants each workman is given a number, which identifies him also on the detail work cards to be discussed later. In some factories each man on entering takes from a checkboard a brass check bearing his number and drops it into a box provided for the purpose. Under other systems he receives his check on leaving the works and deposits it on entering the works again. The timekeeper notes the absentees by means of the checks remaining on the board. Late-comers are noted by the checkboard watchman, so, also, are those leaving early, the latter being passed out on a special card signed by a foreman. Such a system insures an accurate tally of all men entering, and is useful in a very large works, irrespective of other checks which may be employed. Promptness and faithfulness are essential to efficiency, and there is nothing so fatal to the discipline and

the efficient management of a factory as irregular attendance on duty. It should be noted, however, that the checkboard placed at the main entrance of a large works does not insure the prompt arrival of all workmen at their places, and it is often supplemented by other time-recording devices which are placed in the several departments.

2. *Time-recorders.*—In moderate-sized plants the time recorder is much more serviceable than the checkboard. There are many forms of time recorders, but the general principles involved in their use do not differ materially. Usually each workman is provided with a card similar to Figure 12 (page 125). On entering the works he takes his card, which bears his name and number, inserts it in a slot in the recorder and presses a button, or lever, which causes the mechanism to record the time at which this operation is performed, as illustrated in Figure 12. When he leaves the works the operation is repeated, the clock being adjusted in the meantime to print the time in the "out" column. The card is therefore a complete record of the time during which the workman has been in the works, but does not necessarily record his productive time unless used specifically for such a purpose. Such clocks may be placed on the several floors so that, if desired, they may be used also for dating work cards. Where the clock is used simply to check the men coming in and going out, a card of the

form illustrated in Figure 12 is usually employed. In some cases two sets, of different colors, are em-

WEEK ENDING MAY 30 191

No. **154**

NAME

W. H. Harding

DAY	MORNING		AFTERNOON		EXTRA		
	IN	OUT	IN	OUT	IN	OUT	
MON.	M 6 55	M 12 01	M 12 56	M 6 01			
TUE.	T 6 59	T 12 05	T 12 57	T 6 11			
WED.	W 6 58	W 12 01	W 12 59	W 3 30			−2½
THU.	T 6 53	T 12 03	T 12 51	T 6 08	T 6 58	T 10 02	+3
FRI.	F 7 30	F 12 04					−5½
SAT.	S 6 57	S 12 08	S 1 01	S 6 09			
SUN.							

TOTAL TIME *55* HRS.

RATE *32½¢* PER HR.

TOTAL WAGES FOR WEEK, $ *17 88*

FIGURE 12

ployed, one being in use on Monday, Wednesday and Friday and kept in the office on alternate days for posting. The other set is used on the other days in

a similar manner. In simpler systems, where the cost keeping is of less importance, the time record is made on a continuous paper ribbon; and, again, in some systems a clock centrally located is operated by push-buttons which may be variously placed at a distance from the clock.

Methods such as these provide for the accurate recording of the total time worked, but, in general, do not show anything regarding the character of the work performed or the purpose for which it is intended. In the case of certain classes of clerical and administrative employes working at fixed duties and paid by the month, the time-clock record, as noted above, may be sufficient, and in such cases the card shown in Figure 12 may also be used as a payroll, as indicated at the bottom of the card, provided, of course, that the clock record is checked up in the manner to be described. But where it is necessary to make accurate distribution of the labor expended, an additional record must be made.

3. *Traveling timekeeper.*—There are two general methods of collecting the time of each man in detail. Under the first method a traveling timekeeper visits each employe daily, having first checked off the absentees of the day before from the checkboard record, if one is in use. From each man he obtains a record in detail of his work of the previous day—that is, the number of hours expended on each order number. He records in a book the data so obtained, with a memorandum of the class of work or the machine used,

and this serves as the basis of charging up the work to the several orders. Such methods are not to be recommended even in the simple case where every man is on day work. The busy workman is not likely to make a record at the time the work is performed and his memory is unreliable when he is called on to record the result of the previous day's duties. The clerical work involved is also considerable, and where a large number of men are employed, and especially where the number of shop orders is great, the time book becomes bulky and complex. When the piece-work plan and the more complex premium and bonus system are used, the traveling timekeeper is inadequate, especially if the number of men employed is large.

4. *Job tickets.*—The more modern and also more accurate method of obtaining time distribution is by means of the work card, or "job ticket," as it is often called. There are three types of these tickets which may be noted:

(a) The work card which is attached to the material when it is issued from the storeroom, and which accompanies it thru the shop, the labor of each man who works upon it being recorded as the material progresses.

(b) The work card which is issued to the individual workman daily by the foreman, and on which the workman records the details of his day's work, giving the order number of each job worked on and the time expended upon it.

(c) The individual-job work card issued by the foreman to the workman for each and every job worked on, and on which is recorded the order number and the time expended on one job only.

The limitations of the first type are obvious. In small shops and for certain classes of work it is applicable, but the constant handling of such cards, in a machine shop, for instance, reduces them in a short time to an unintelligible state. Furthermore, the accuracy of the information thus gained is open to question and it cannot be recorded conveniently until the job is finished; as a result, therefore, there is a lag in the cost records.

The second form of job ticket is shown in Figure 13 (page 129). Upon this ticket provision is made for noting the time expended on the several orders on which the man has worked during the day. Its sole advantage, therefore, over the traveling-timekeeper method is that the workman is provided with a systematic method of keeping his own time, but it is open to the same criticism of possible inaccuracy as is the timekeeper system. The second form of card is superior to the first, however, since by means of it returns are made daily, and can be checked more readily by the foreman as they are turned in. These returns can also be used to check up the time recorded by the workman on the time clock or checkboard at the shop entrance. The work of posting up the time charges against the several order numbers is cumbersome, however, if there are many

such orders in progress; moreover, they are awkward to analyze for the purpose of making cost reports, because the work on several order numbers may be placed on the same job ticket, as shown in Figure 13. It is difficult, also, to trace disputed items after the job tickets have been posted, since they cannot be filed under separate order numbers.

DAILY-TIME TICKET

DATE May 1 191_

WORKMAN'S NO. 36 NAME John Smith

JOB NO.	OPERATION	HOURS	RATE	VALUE	
60	Boring	2	.30		60
175	"	3½	"	1	05
254	"	2½	"		75
75	"	2	"		60
			TOTAL	3	00

FOREMAN Wm Jones

FIGURE 13

The third type of ticket is by far the most flexible and the most commonly used. As before stated, a separate ticket is issued to each man for each job worked on each day and all tickets are collected daily. Figure 14 (page 130) illustrates such a card arranged for day work. It bears the workman's name and number, the date, and the order number of the job. It may be arranged, as in Figure 14, so that the work-

DAYWORKER'S CARD

MAN'S NO.	DEPT.	DATE	ORDER NO.

DRAW NO.	PATT. OR PRT. NO.	NO. PIECES	O.T.	HOURS	RATE	VALUE

DESCRIPTION OF WORK

6	½	7	½	8	½	9	½	10	½	11	½	12	1	½	2	½
3	½	4	½	5	½	6	½	7	½	8	½	9	½	10	½	

APPROVED____

FOREMAN

1 ASSEMBLING
2 BALANCING
3 BANDING
4 BUILD. UP
5 BURR. SEGMENTS
6 CHIPPING
7 CLOSING UP
8 FITTING
9 HOT PRESS
10 PRESS ON COM.
11 PRESS ON COLL.
12 RIVETING
13 SOLDERING
14 TAKING DOWN
15 PAINTING
16 CONNECTING
17 INSULATING

Figure 14

PIECEWORKER'S CARD

MAN'S NO.	DEPT.	DATE	ORDER NO.

MAN'S NAME

DRAW NO.	PATT. OR PRT. NO.	OPERATION NO.	HRS.	PIECES	PRICE	VALUE
					PER	
					PER	
					PER	
					PER	
					PER	

6	½	7	½	8	½	9	½	10	½	11	½	12	1	½	2	½
3	½	4	½	5	½	6	½	7	½	8	½	9	½	10	½	

APPROVED____

FOREMAN

1 ASSEMBLING
2 BALANCING
3 BANDING
4 BUILD. UP
5 BURR. SEGMENTS
6 CHIPPING
7 CLOSING UP
8 FITTING
9 HOT PRESS
10 PRESS ON COM.
11 PRESS ON COLL.
12 RIVETING
13 SOLDERING
14 TAKING DOWN
15 PAINTING
16 CONNECTING
17 INSULATING

Figure 15

man may check off not only the elapsed time expended on the job, but also the character of the operation involved. Thus the need of any writing on the part of the workman is obviated and by so doing much time is saved and mistakes due to illegibility are avoided.

Figure 15, opposite, shows a similar card arranged for pieceworkers. In addition to the general information given on the dayworker's card this card records the number of pieces, the rate per piece, and also the elapsed time. This last has nothing to do with the workman's pay, but is recorded so as to check up the total time against the clock record, for reasons already noted.

Figure 16 (page 132) illustrates a work card which has been used by Mr. Gantt for recording bonus time. It records the time allowed, the time actually taken, the bonus and the total time for which payment is to be made. Provision is also made for the inspector's approval for both quality and quantity.

All of these cards, as will be noted, record full information regarding the job. They all record the workman's name and number, the order number, the part and drawing numbers, as well as full information regarding the operation performed. The operation and its cost are therefore identified fully with the order number, and full information is recorded for statistical use, if this be desired. The forms of job ticket shown in Figures 14, 15 and 16 lend themselves admirably to statistical purposes, for, since only one

order number is recorded on each ticket, the sorting and arranging of these tickets by order number and classes is an easy matter.

ISS'D RET'D	JUN 2 7-00 AM 1918 JUN 2 6-00 PM 1918	PART AND ORDER NO. 14783–5
MAN'S NAME Doe, John		MAN'S NO. P.M.23
TIME ALLOWED 10.00	TIME TAKEN 10.00	FINISHED NOT FINISHED
BONUS 2.50	HOURLY RATE 30	TRANSFERRED
PAY FOR 12.50	WAGES 3 75	BREAKDOWN CAUGHT UP
NAME OF PART OR JOB Bolts		

OPERATION NAME	OPER. NO.	MACHINE NO.	NO. PIECES FINISHED	SYMBOL	WAGES	
Forming	1	DPM 18B	30	PM6B		

ENTERED IN					O.K. FOR QUALITY	O.K. FOR QUANTITY
DEPT. LAYOUT	A E RECORD	SCHED-ULE	PAY-ROLL	COST RECORD		
						Form APR 14

Figure 16—Work Card for Bonus Workers

5. *Other time-recording devices.*—While the job tickets discussed in the preceding article assist greatly in securing accurate time records, it is clear that they are not proof against errors, especially in the hands of ignorant or careless workmen. For this reason,

provision is sometimes made for stamping the time of starting and the time of finishing each job by means of a time-clock instead of having the workman check them off by hand. This is illustrated in Figure 16, on the upper left side of the card. In such cases the time of starting the work is stamped on the card by the assistant to the foreman, and when the operation is completed the workman presents the card to the assistant, who stamps the time of completion and issues a new card with a new starting time stamped thereon. Another device, a form of time-clock which prints elapsed time, has also been used to facilitate the operation of time recording. There are a number of such devices now in use, some of which have proved to be very practical. These differing methods in no way affect the essential principles involved, being of the nature of mechanical aids only.

One fundamental principle should be carefully observed, whatever may be the system of time recording, namely: Every piece of direct production should have a distinctive order number assigned to it, and every kind of indirect work should have a permanent or standing-order number which remains fixed until changed by the cost keeper. No work of any kind should be performed that is not authorized by the proper officials and covered by a production order or a standing-order number.

6. *Summarizing time and labor returns.*—All work cards are usually approved by the proper foremen

and are then forwarded to the timekeeper, who checks the daily total of each man's card with his clock or checkboard record. These should of course agree. If the worker is on day pay this total forms the basis of his daily wage. If, however, he is on piece or premium work, the proper additional data must be added to the payroll, tho the total time recorded must check as before. The exact method of recording premium and bonus earnings will necessarily vary with the character of the work and the pay system in use, but in any case there should be an exact balance between the payroll and the labor values recorded on the cost sheets. As has been shown, it may not always be necessary for all men to hand in a work card, because their duties are simple and constant, and a record of the time expended is sufficient to evaluate their services and distribute their cost. As a general principle, however, it is good policy to have every man whose name is on the weekly payroll hand in a work card, so that the two systems of recording time will exactly balance.

After the timekeeper has taken the data for the payroll, the work cards are forwarded to the cost keeper, who sorts the cards by order numbers and charges up on the cost ledger the costs on each card against the order number which it bears. This work is greatly facilitated by making the work cards of different colors so that they can be sorted rapidly. The charges made to the several order numbers are summarized periodically and carried forward to the

general ledger in condensed form. They form the basis of various kinds of reports, which will be discussed in a succeeding chapter. These detail and summarized time charges contain valuable information that can be compiled and compared and the information thus gained may be of great benefit to the manufacturing superintendent. The general method of analyzing this information and presenting it in the form of condensed reports is fully discussed in Chapter XVIII. The methods of recording time, discussed in the preceding section, are comprehensive, and applicable even in very complex manufacturing. It will be clear, also, that as the enterprise considered approaches more closely the continuous type of manufacturing, the methods for recording the time expended become correspondingly simpler.

7. *Other items of labor costs.*—In the foregoing discussion it has been assumed that there is no time lost between jobs and that the time of finishing one job is the time of beginning another. Such close connection is not always made, however, and if much time intervenes between jobs, care should be taken that such time is not charged against production orders, tho this actually is often done; in fact, such procedure is even advocated by some writers. Certainly such loose time accounting will vitiate any system of cost accounting; lost time of this nature should be charged to an expense account provided for that purpose. Other items of lost time, such as time paid

for without return, as in cases of accident, temporary stopping of machinery, etc., should be similarly handled. A careful record should be kept of these items and they should be analyzed with a view to minimizing such losses. Many managers would be surprised to know how much time is lost in this manner simply because it is never brought before them in a collected form.

It might be said in passing that time losses between jobs can be greatly lessened by planning the work in advance, a procedure that is entirely in keeping with modern ideas of management. A bricklayer cannot lay bricks unless he has them at hand. Even when the workman is on piecework, and is the apparent loser thru lost time, it should be remembered that the factory loses by any reduction in output, since profits depend on quantity produced, as much as they do on profits per piece. Every effort should be made, therefore, to have work moved from operation to operation promptly and quickly, and all work, if possible, should be studied in advance, to insure the best and most direct sequence of operations.

It should be noted, also, that the discussion of time-saving applies not only to direct labor but even more particularly to indirect labor. As will be shown later, the indirect labor may be, and often is, a large part of the wage cost. The time-saving principles and time-recording methods that are found useful in connection with the man at the machine, will also be

found advantageous in connection with the clerk in the office or the helper in the yard.

REVIEW

What kind of work card would you lay out for (1) daywork; (2) piecework; (3) premium or bonus work?

What system of time recording would you adopt in a factory employing common labor of a low mental type?

What do you understand by the term "job ticket"?

How many types of job tickets are there, and what are the advantages and disadvantages of each type?

Of what importance is it to know the causes of idle time?

What are the various purposes of collected time cards?

CHAPTER X

EXPENSE OR BURDEN

1. *Character of expense.*—It was shown in Chapter II that many items of labor and material that are essential to the operation of the enterprise cannot be directly connected with any particular piece of product. An examination of Figure 2 (page 21), and also of the expense accounts listed in Section 1, Chapter IV, will make this fact clearer. It holds true of practically all enterprises of any magnitude, and follows directly as a result of division of labor. It will be remembered, also (see Section 8, Chapter III), that it is always desirable to segregate the shop costs from the selling and other costs, if for no other reason than to render it possible to hold the proper individuals responsible for these costs. Under the general name of "factory expense," or "burden," is included, therefore, all labor, all material, and all other items of manufacturing cost that cannot be charged directly to some particular piece of production. It will be noted that while, in general, all such material and labor are of the indirect kind, certain expense material may go directly into the product. Thus, nails, screws, glue, and similar items, may be used in such small quantities on each piece of product as to make direct ac-

counting difficult, if not impossible. Items of this kind are therefore carried to an expense account and distributed with other expense items.

The general character of selling expense and office, or administrative, expense is shown in Section 1, Chapter IV, and it should again be carefully noted that, while these two classes of expense are often gathered up under the one head "general expense," they are essentially independent quantities. In fact, if the selling expense is of any consequence it should be segregated. Moreover, as will be shown, it is often desirable, as the enterprise increases in size, to subdivide shop, administrative and selling expense so as to hold each *department* of these activities responsible for its own just share of the expenditures.

Many items of expense do not naturally attach themselves quantitatively to machines or processes, but gather like clouds, of greater or less density, over the entire enterprise. There is no great difficulty, as has been shown, in finding the cost of the direct labor and the direct material that enter into a product. Nor is it a matter of great difficulty to classify the many items entering into the expense and to find the total amount of such classes for any given length of time. The charging off of this total expense over the total product for any particular period of time presents, also, a simple problem. But it is exceedingly difficult, except in very simple cases, to assign to each shop order its own share of expense with any great degree of accuracy. The principal problem of cost find-

ing is so to assign the expense, or burden, that each article shall bear its own share, and only its own share. This problem may be made a little clearer by a further consideration of the characteristics of expense.

2. *Expense fluctuation with volume of business.*—An examination of the expense items of any enterprise will show that while some are fairly constant in amount, others go up and down with the volume of the business, tho according to different laws. In a general way the items that are constant include all expense incident to the existence of the enterprise, irrespective of productive operations. Thus, such items as rent, taxes, insurance, depreciation of buildings, and the like, do not vary materially, whether the enterprise is active or not; or, if they do vary, the change is likely to be occasional and by large amounts. Otherwise, they remain fairly fixed for long periods. Such expense, furthermore, can never become zero, no matter what the volume of business may be. The salaries of permanent officials are of this character and are not affected, in general, by changes in the volume of business. Depreciation, it should be noted, may be even greater when the factory is idle than when it is in operation, since then many ordinary measures for preventing depreciation are not active.

Other items of expense, on the other hand, are affected quickly by changes in the volume of business. Thus, clerical help, indirect labor and operating supplies are directly affected by such changes, moving up and down as the volume varies—tho not, as a rule,

in direct proportion to such variations. For instance, it requires a definite minimum amount of oil to lubricate the shafting of a factory, whether any machines are in operation or not, and any further amount of oil that may be necessary is obviously dependent upon the volume of work passing thru the shop. This relation is usually so complex that it cannot be expressed in terms of any fixed factor of production. In general, however, the relation between the amount of oil used and the volume of output may be expressed thus:

$$Q = K + f\ (V)$$

where $Q =$ the quantity of oil, $K =$ a constant, and $f\ (V) =$ some function of the volume of work. Many other expense items, such as power, light, and some kinds of indirect labor, are of this general character.

It is important to notice, however, that from this it is clear that profits do not vary proportionally with the volume of business. Half-volume does not mean half-profits, since there is always an irreducible minimum of expense; and if this irreducible minimum is high compared with the variable expenses due to the activities of the business, a comparatively small decrease in business may eliminate all profits, if it does not actually cause a deficit.

3. *Variations of expense due to time.*—Expense, again, may vary according to time. Thus, a large amount of coal may be purchased, either to take ad-

vantage of the market, or to provide for emergencies; but the use of this coal may extend over weeks or even months. The demand for certain kinds of expense material may vary with the season. Thus more coal is needed in the winter season, while ice is needed particularly in the summer. Extensive repairs may be made to buildings or machinery because of the wear and tear incident to the work of previous weeks or months. These and similar expenses may fluctuate greatly and with little reference to the volume of business. Yet, clearly, it would not be fair to current production to charge off such heavy expenses against it, thus unduly favoring either future or past production. Such expenses must be averaged over a reasonable period of time, even tho the method of fixing such an average may be more or less arbitrary. Of course, when the products of the factory are seasonable—that is, when some kinds are made only in the winter, and other kinds only in the summer—there may be expenses that can be allocated justly on a seasonable basis, but this case is uncommon.

Expense must often be charged off by an average rate, for still other reasons. Once a month is about as often as it is convenient or desirable to close the general books and summarize all accounts, direct and indirect. If it were possible to start each job on the first day of the month and finish it on the last day, it would be possible to allocate to each job, with fair accuracy, a proper and fair share of the total monthly expense. Such conditions, as a matter of fact, are

never found, since all work must be started and finished regardless of the day of the month. Expense must, therefore, be allocated on the basis of summarized expense costs of the past month, or months, the data for the current month not usually being available.

Some cost accountants prefer to use the expense data of the preceding month only, on the ground that conditions do not change from one month to the next as much as they do during a period of several months. If this is done, however, special attention must be paid to large periodic expenses which are properly chargeable over a considerable period of time. This difficulty of determining with accuracy the expense items that have been incurred during the time a particular piece of work has been in process of production, and the expenses which are logically an integral part of the cost of producing that work, should be carefully considered, for the problem that it presents involves factors that prevent any cost system from being very accurate.

4. *Expense variation with character and size of work.*—The amount of expense which any part should bear will also vary with the character of the operations performed upon it. Thus, in a plant manufacturing electrical appliances some parts must be dipped in insulating material and perhaps baked. Other parts will not require such treatment and, clearly, they should not, to be exact, bear any of the expense of the insulating department. In fac-

tories producing different lines and involving both intermittent and continuous manufacturing processes, such conditions are often met, and they sometimes offer a difficult problem in cost finding.

The amount of burden that a part is justly entitled to bear may vary also with its size or weight. Strictly speaking, small parts should not bear any part of the expense due to crane service and large equipment in general. Theoretically at least, a large casting should bear a greater share of the repairs to the cupola than should be charged against a small one.

This problem is a difficult one in factories producing lines of goods that have a large range in size, where competition is carried on with other factories each one of which produces only a small part of the range. Other things being equal, a factory producing a full line of electric motors ranging from one-quarter horsepower to 5,000 horsepower would have difficulty in competing with a company producing motors from one-quarter horsepower to ten horsepower, unless special care were taken to prevent the larger costs due to the larger product from being unjustly charged against the smaller product that does not require the larger equipment for its production. To differentiate such charges is, however, often a difficult matter, but the difficulty can be lessened by careful departmentization which will bring parts of like kind and equal size under the same departmental organization.

5. *Clerical and selling expenses.*—These problems and difficulties are common to office and shop alike. Clerical work is, in general, difficult of exact allocation, particularly where the product is varied and complex. It may, and usually does, involve more expense to do the clerical work connected with making a small, complicated machine than it does to take care of the clerical work connected with a much larger and costlier product. This is particularly true where costs are required in detail, since, in that case, the number of production orders may be very great for the small, complex machine as compared with the large, simple machine. For the same reasons, the cost of superintending the production of the small machine and of collecting the labor and material costs may be excessive as compared with the case of the large machine.

What is true of the factory office is obviously true also of the general office and the sales office, the expenses of these last departments being particularly vague, so far as allocation to any one job is concerned. The cost, for instance, of doing the business connected with selling standard product, which is well-established in the market and practically sells itself, is much less in proportion than that involved in selling special sizes or types or in disposing of product for which a field must be created. Yet, practically, it is often difficult to segregate these expenses. This is markedly true of the work of the salesman, who frequently labors in vain, or whose reward comes in the

form of sales for which the "missionary" work was performed a long time in advance.

6. *Two purposes of expense distribution.*—Aside from the general characteristics of expense which have just been discussed, each item of expense has special characteristics that must be considered in connection with its distribution against production. Certain expenses, such as fuel, oil and certain kinds of indirect labor, are clearly chargeable against manufacturing expense, while other items are just as clearly chargeable against general expense or selling expense. In segregating and classifying expense it should be remembered that the object in view is two-fold:

(a) To allocate each item as fairly and as accurately as is possible or desirable.

(b) To record and summarize each class of expense in such detail as will make possible its analysis and clearly show its content.

The first requirement involves a consideration of methods of distributing expense, which will be discussed in Chapter XIII; while the second requirement governs the detail in which any item of expense shall be collected and recorded. This last requirement will now be considered briefly.

7. *Classifying expense factors.*—As noted in Section 8, Chapter III, a clear-cut distinction should be made, if possible, between manufacturing expense and general expense. This is necessary, if for no other reason than to fix responsibility for such expenditures.

The manufacturing superintendent should be held strictly responsible for the expenses that are a legitimate part of production, and for those expenses only. The general manager should assume responsibility for the general expenses which are incurred by the managing and accounting branches of the business. In small enterprises the sales expenses are often included in the general expense, but usually it is considered better to collect the sales expenses separately, so as to be able to hold the sales manager responsible for his own expenditures. When this responsibility has been determined, however, there is no gain in keeping these expenses separated, and for convenience they are generally merged and distributed against the product as one expense.

It is not always possible to make an absolute division of expense between these two classes, because the organizations of industrial enterprises differ so widely. Thus the president may also be the sales manager, and the duties of other officials may include supervision of the manufacturing and general activities of the business. However, even in such cases a proportional division of their salaries can always be made that will be equitable to all concerned.

In Figure 17 (page 148) is shown a classified analysis of the cost of production, including selling costs, as it occurs in an average manufacturing plant. Only typical items are shown, since the detail in which it is necessary or desirable to take account of expense depends entirely upon the industry and the size of the

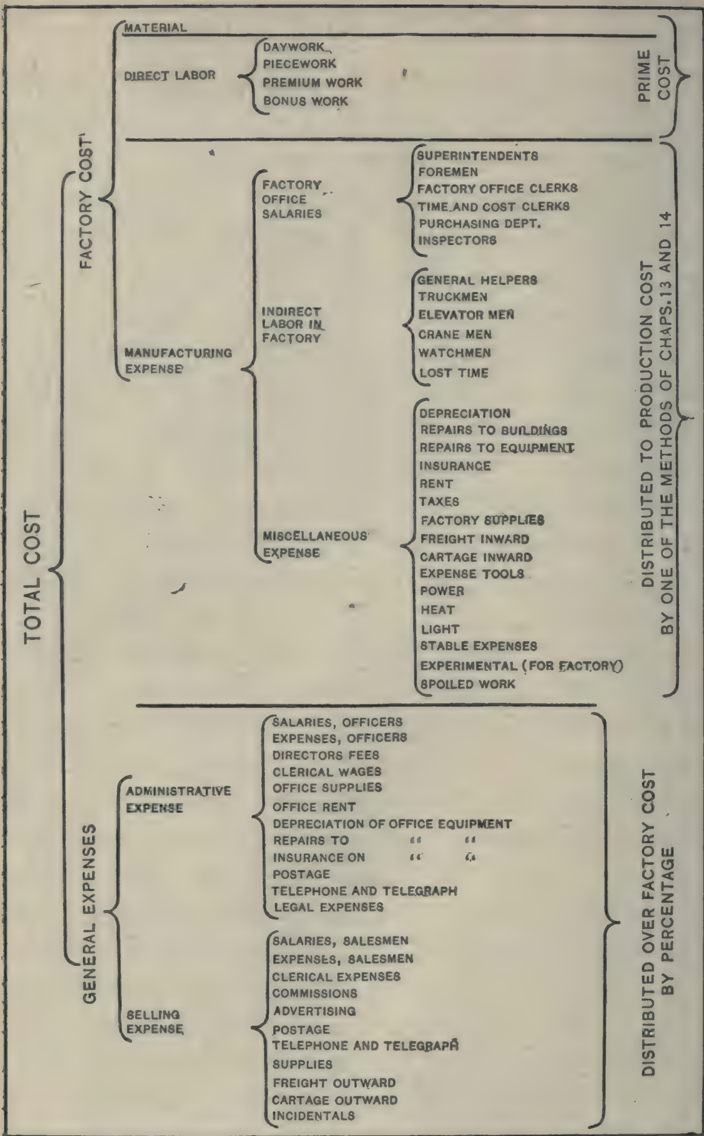

Figure 17—Distribution of Production and Selling Costs

enterprise; one very large factory in this country has no less than 130 expense accounts. As the size of an enterprise increases, all items of expense assume greater importance and segregation becomes more and more imperative. Each factory expense account should be designated by some number or symbol similar to those used for production accounts, as explained in Chapter IV, and no charge should be made against any account unless it is authorized by a written order from the proper official. The classification given in Figure 17 is in general accord with the practice of skilled accountants and cost keepers. To distribute logically the great majority of these accounts among manufacturing expense, general office expense and selling expense, is not, as a rule, difficult in any particular case; but there are a few items on which all cost keepers and accountants are not agreed, concerning which more detailed discussion may be helpful. These are rent, interest, taxes, insurance, defective material and spoiled work, lost time, engineering and development, repairs and improvements, patterns, drawings and small tools, and depreciation.

8. *Theoretical consideration of interest and rent.*— To the accountant rent and interest are identical, since rent is money paid to a capitalist for the use of buildings or equipment, while interest is money paid for the use of capital. There is a considerable difference of opinion, however, among accountants and cost-finding experts as to the way in which these

items should be cared for in the accounts. Some authorities would not include either of them in the details of factory costs but would add them to the total factory costs, carrying the transaction in the general ledger. Others would include all such items in the factory costs as a true part of the cost of production. Some would include rent but not interest as a part of factory costs, but this view is not reasonable, considering the similarity of the two items.

The argument advanced by those who would exclude rent and interest from factory cost is that these items being attributes of capital are in the nature of a division of profits, and should therefore be accounted for by deducting them from profits. The argument is also advanced that the manner in which the capital is obtained can in no way affect the actual cost of manufacture. It is urged that the manufacturer may provide all of the capital, or that he may borrow a part of it from others, dividing a part of the profits of the enterprise with these other capitalists, in the form of rent or interest, but that no part of these items is a logical part of the costs.

Now, it is true that to the man who lends facilities or money, rent and interest are in the nature of profit, but to the manufacturer who has borrowed these facilities or money, rent and interest are simply debts that must be paid before he can obtain a profit. So far as simply securing this profit is concerned, it makes no real difference to him whether these items are distributed in the costs or are added to the costs before

fixing the selling price. If the clerical work is accurately done the result will be exactly the same in either case.

9. *Practical consideration of interest and rent.*—It should be remembered, however, that the purpose of cost finding is not to decide theoretical points in economics, but to allocate all expenditures so that the cost of each article shall be segregated as far as possible, and so that it will be possible to tell which lines of production are paying and which are not. If, now, the manufacturer is producing his goods with borrowed money, on machinery of varying value, housed in buildings of varying cost, it is obvious that, unless rent and interest are distributed against the product in proportion to the use made of the facilities of the plant, he can form no definite idea as to the comparative profit-earning values of his several lines of product. There is just the same reason, in fact, for distinguishing, in these matters, between different departments or machines of the same factory, as there is in distinguishing between different factories owned by the same man, tho he may have borrowed from the same source all the money with which to erect his different factories. In the case of a simple continuous industry it is not necessary, of course, to distinguish so finely in these matters, since each unit of product bears the same amount of each kind of expense.

It will be noted, however, that when money is borrowed for commercial purposes, and not for investment, or use in manufacturing facilities, the status of

interest paid upon such indebtedness is different. Thus, if the commercial department borrows money so as to be able to extend credit to customers whose accounts are due, or if money is borrowed at a low rate to discount purchase invoices at a higher rate, such interest and discounts have no relation to the cost of production, but belong to the general, or sales, accounts and should be considered accordingly.

10. *Interest on owned capital.*—The case where the manufacturer owns his plant would seem, at first sight, to be somewhat different; for here, apparently, he does not need to include interest charges on his investment, in computing either his factory cost or his total cost. A brief reflection, however, will show that the case referred to is only seemingly different. If the owner of an enterprise cannot make a profit over and above interest charges on his investment, it would be easier for him to lend his money to some other person, who would pay him such interest and assume all the risks and responsibilities of the business. The owner could then work for some one else and earn a wage. These facts would seem to indicate that the wages of an operating owner should also be considered a part of the cost of production and should not come out of profits. It is clear, of course, that the manufacturer who owns his plant has a great advantage over one who rents his plant, since the latter must make a minimum profit to meet his interest charges, while the former is not necessarily in any danger, even tho his investment does

not pay him the market rates of interest. From the standpoint of practical cost finding it would seem clear that a reasonable allowance for interest on the investment should be distributed in the factory costs, if for no other purpose than to determine the comparative profit-earning capacity of the several lines of output.

This general principle was approved by a committee on uniform cost accounting of the National Machine Tool Builders' Association, which recommended that interest at the rate of at least five per cent on the investment be distributed in the burden, where the manufacturer owns his own plant. This committee recommended also that where the manufacturer rented his facilities, or borrowed his capital, the rent and interest should be included in the factory costs, in accordance with the arguments presented in Section 9 of this chapter.

These views, as before noted, are not held by all cost experts and accountants. Tho the practice of including interest and rent in costs is now common, it is argued that the inclusion of these items in the factory costs may raise the total costs above the market price, and that it is better to defer such charges till the end of the year, or such other period when the general books are closed, and then to make whatever allowance is desirable. In reply to this argument it may be said that costs are costs, and that it is far better and safer to determine them as accurately as possible, and then, if they cannot meet the market prices, proceed to re-

duce them by economies, or better methods, till the desired margin is secured. A careful comparison of the earnings of each tool with the interest on the investment involved, would often lead to the discarding of the tool, a change in the product, or a higher charge for the services of the tool.[1]

REVIEW

How will the individual items of expense burden shown in Figure 17 vary on account of the following factors: Volume? time? character and size of work done?

Why should interest on owned capital be charged as a part of manufacturing expense? What rate would you select?

What is the purpose of expense distribution?

Is rent properly included as an item of manufacturing expense? Give reasons.

[1] A fuller discussion of this subject with the arguments for and against the position here taken will be found in the Modern Business Text on "Financial and Business Statements."

CHAPTER XI

EXPENSE OR BURDEN (*Continued*)

1. *Taxes and insurance.*—These arguments regarding interest and rent are applicable as well, in their entirety, to taxes and insurance, which are also sometimes considered as attributes of capital, and are therefore included in the general costs. Accurately proportional allocation of costs requires that they also be distributed in the manufacturing expense. This proportional allocation should take account not only of the varying value of buildings and equipment, but also, in cases where the material is costly, of the value of the material in process in each department.

Taxes and insurance are excellent examples of periodic expenses which really are chargeable over the product turned out during the particular period covered by the payment. These items, being usually paid in advance, are most logically cared for by carrying them to a "suspense account" from which they can be charged off monthly into the costs. Other expense items, such as coal, for example, can be conveniently handled in a similar manner.

2. *Defective material and spoiled work.*—It would seem logical, at first sight, to charge the cost of defective castings and spoiled work to the order number

of the job in which these occur. Where the defective or spoiled part is one of a very large lot this procedure would be proper; or if the work is so unusually difficult that bad castings or defective workmanship are likely to occur to a greater extent than in the ordinary run of work, it is clear that the extra cost so incurred should be charged to the product or class of work concerned, since it is, in general, a more costly line of goods to produce.

The cost of an occasional bad casting or a spoiled part should not, however, be charged against the particular job in which it occurs. Such items of cost should be carried to a separate account (see Figure 17, page 148), and charged off in the manufacturing expense, for thus it will be possible to distribute these losses as a light tax over the entire product. If the cost of occasional misfortunes is charged to the individual jobs on which they occur, some jobs will be penalized to such a degree as to raise their cost out of all proportion, and it will be practically impossible to determine what the true cost should be. Clearly, also, all such costs should be entered in the records as separate items, so that no confusion may arise in estimating upon new work, in which such occasional losses may not occur. All such losses should be reported on a special form, and should also come under the eye of the superintendent. The report should give full information regarding the defective material or the spoiled work, the names of all men concerned, the reason for the loss, etc. Furthermore, the total of the

account to which these items are carried should be carefully scanned, since it is an index of the efficiency of certain phases of production.

Defective purchased material should, of course, be carried in a separate account, if for no other reason, to fix responsibility for the entailed losses. Such losses, however, are also manufacturing expenses and should be distributed accordingly.

3. *Lost time.*—In every enterprise there is usually a considerable amount of time for which payment is made but for which no return is received in productive effort. Thus, there may be considerable time lost by the stopping of machinery for short spaces of time, temporary extinguishment of the lights, cleaning of machinery, and in waiting for material, tools or information. It is clear that, in general, such costs should not be allocated to particular jobs, if the cost records are to serve as a means of predicting future performance. Furthermore, lost time, like spoiled work, is a measure of efficiency in management. Much of the lost time in the majority of plants could be saved by careful planning of the work and careful examination and repair of machinery in advance. The general principle of planning work and repairs in advance is one of the cardinal principles of modern industrial engineering, and is well worth the consideration of all managers. (See also Section 7, Chapter IX.)

Lost time, like spoiled work, should be carried to a separate account (see Figure 17) and distributed in

the expense. This also gives the management an opportunity to check up the total of such time losses and to exercise supervision over it in a manner not attainable if such losses are buried in the job costs.

4. *Engineering and development.*—In many enterprises there are certain expenditures the distribution of which will vary with conditions. Engineering and similar work, for instance, may be for one of three purposes:

(1) For securing specific contracts

(2) For specific contracts already secured

(3) For the production of standard product, either for orders on hand, or to be received.

Engineering and other preliminary work performed for the express purpose of securing contracts is purely commercial in character and should be charged to selling expense. Work of this kind may include designs, blue-prints and estimates of considerable cost. Clearly, the manufacturing department should not bear an expense of this nature, often very heavy, with which it is in no way concerned.

Should the contract be secured, and should the preliminary work be used in the actual construction, the cost of the preliminary work may be divided between selling expense and manufacturing expense; or, in some cases, it may justifiably be charged entirely to manufacturing. This should never be done, however, if the contract for which the preliminary work was done is not secured. In that case it is a selling expense, pure and simple, and if entered in the selling

expenses it has some significance; on the other hand, it is not only poor accounting to charge such preliminary work to manufacturing expense, but it is poor management, generally, because such procedure results in general confusion in the manufacturing expense account.

In the case of specific contracts for products which are not likely to be built a second time, it is obvious that, as far as possible, all cost pertaining to the product should be charged against it. All engineering, and all special experimental work, special tools, etc., then become direct costs of production chargeable against the work with which they are connected. Some manufacturers consider all drawings and patterns as assets and charge their value to capital account. In the case of special contracts which are not likely to be repeated such a procedure is seldom justifiable. It is better and safer to charge all expenditures made on special product to the cost of that product if any doubt exists regarding the special facilities, so provided, being used elsewhere.

Engineering and development work done on standard product which is passing thru the factory in quantity is of a different character and cannot be allocated to jobs; it must be treated as manufacturing expense. It is, of course, often possible to segregate such expenses where they are incurred for specific lines of product, and charge them off against those particular lines; but in complex cases even this may be difficult. Thus, experimental work conducted to perfect

the theory of the design of electric transformers would be applicable to all sizes of transformers but not applicable to electric generators. Yet it would be difficult in a medium-sized shop to allocate this expense solely to transformers, and it would be still more difficult to make each size of transformers bear its proportional share of this burden.

Engineering and experimental work that has for its purpose the development of better manufacturing methods is clearly also a manufacturing expense; but similar work conducted for the development of new lines of product is somewhat different in character. Clearly, also, such work is not chargeable to selling expense. A good way of handling expenditures for new development is to carry them to a development, or suspense, account until it is decided whether or not the line of product under consideration will be built. If it is decided to produce the line of goods this preliminary expense can be charged off against the line over an estimated quantity of product. Such a method of distribution must, of course, be approximate, but, nevertheless, it is much more accurate than charging such expense to other lines of product. If this method is not feasible or desirable, the development account must be closed into the factory expense and distributed by whatever method is in use. If it is decided not to manufacture the line of goods, the development cost should be charged off in the general expense. In any case, great care should be exercised in carrying develop-

ment work as an asset, as is sometimes done. If so treated, and if the asset be at all of a perishable character—whether drawings, machines or engineering data—the development cost should be depreciated as rapidly as possible by deductions from revenue account.

5. *Patterns, drawings and small tools.*—The problem of patterns and drawings is very similar, in some respects, to that of engineering and experimental work. It is the practice of some manufacturers to carry patterns and drawings as an asset, when they are used continuously in production. Great care should be taken in doing this. At best, patterns are short-lived when used; if not used they soon become valueless. Any one who has ever critically examined an old pattern storage knows how useless are most of the patterns found in such places. Wherever patterns or drawings are made for specific jobs, and are not likely to be used elsewhere, they should undoubtedly be charged directly to production. Where patterns are used continuously on standard production they can be charged off, pro rata, over an estimated amount of production. Iron patterns, while they are more durable than patterns made of wood, and while they possess some residual value after they are worn out, should be paid for out of production as quickly as possible; for, tho they may be valuable to the enterprise while it is a "going concern," their value as an asset at a forced sale would be very small.

Drawings, tho undoubtedly a true asset while in use in a "going concern," are of little market value

and should, in any case, be carried at a very low valuation. It is better to charge off such investments by averaging them over an assumed quantity of product. Thus, pattern costs are often absorbed as a charge on foundry cost, and drawings can be absorbed in the manner suggested in the preceding paragraph.

Short-lived, small, loose equipment, in general, and hand tools which wear out rapidly, should either be carried at a very low valuation or be renewed out of revenue and charged off as an expense.

6. *Special apparatus.*—In many manufacturing plants very large sums of money are tied up in jigs, fixtures and special tools. The problem of the extent to which it is justifiable to make such special tools is an interesting one, often involving other factors besides the element of cost, as, for instance, accuracy of form. Generally speaking, however, the making of special machinery should be justifiable from the standpoint of cost of production, but great care should be used in disposing of the cost of such tools. Special tools are, most often, applicable only to the work for which they are made, and, if the line of goods for which they are used should be discontinued, or if the enterprise should go out of business, the value of such equipment is always problematic and in many cases such material is worthless except as scrap. In the case of small equipment, such as jigs and drilling fixtures, it is an unwise policy to carry their value as an asset. Such value should be considered as a part of the cost of production of the particular line of goods

for which the tools have been made, and that value should be distributed over the cost of such goods. This usually involves the creation of a development, or suspense, account covering the original cost of such tools, and an estimate of the probable number of parts to be manufactured, to fully absorb this account.

In the case of large, special machines it may be desirable to consider them as a real asset. But, again, careful judgment should be exercised in such a proceeding. Unless it is clear that such tools are likely to outlive their usefulness by the natural processes of wear and tear, rather than by obsolescence, they should be liberally depreciated at inventory time, to a point where their loss would not be a serious factor. To any one familiar with the collection of old special tools to be found in any factory operating on mass production, the wisdom of such procedure will be obvious. It is essential, therefore, either to bury the cost of special tools in the cost of production, or to see to it that the tools are depreciated to a value that will permit of safely carrying them as an asset. There is no doubt that the neglect of the above principles lies at the root of many industrial failures.

7. *Improvements and repairs.*—A careful distinction should be made between improvements and repairs. Any addition which adds to the earning capacity is obviously an asset and should be so considered. But even here it is good policy to limit the minimum value of the improvements which are treated as assets, since it is always desirable that charges to

capital should consist of important items the value of which, as assets, cannot be questioned. This minimum limit will, of course, vary with the size and the character of the enterprise; in small shops it is perhaps as low as fifty dollars. Any betterments of lesser value should be treated as repairs and carried to the expense account.

When a machine, or other piece of apparatus, is rebuilt or has extensive improvements made upon it, the changes may sometimes be such as will add materially to the producing or earning capacity of the apparatus; they may constitute a true betterment that may be added to the assets. Thus, a machine may be thoroly repaired and, at the same time, equipped with a motor drive. Care should be exercised to make certain in each case that the producing capacity has really been raised before the inventory value of the machine is actually increased.

Repairs of all kinds are in the nature of expense. They are also closely connected with depreciation, which is discussed in Chapter XII. The detail in which repair costs should be collected and recorded will, of course, vary with the enterprise; but there are certain broad classifications that are fundamental and general, as, for instance, repairs to buildings, repairs to machinery, repairs to small tools and loose plant, and repairs to furniture and miscellaneous fixtures (see Figure 17, page 148). Each of these general divisions may be, and usually is, subdivided into smaller accounts, the detail often being minute in

large plants. In any case, the detail should be such that the responsibility of departments and foremen is clearly shown. This is usually accomplished, as before noted, by a system of standing-order numbers (Section 5, Chapter IX), to which labor and material are charged in the same manner as in the case of productive work.

8. *Inclusion of burden in cost of repairs.*—It is customary in many establishments to consider the material and labor actually used in making repairs as constituting the full cost of such repairs, and no addition is made thereto for other expenses as in the case of a product made for the market. This procedure, however, may in some cases be open to question. If repairs are made on a building, for instance, with material and labor bought directly for the work, it would be reasonable to charge any expense for supervision, purchasing costs, etc., to the cost of the repairs, but since no use is made of the machinery and equipment in making these repairs no other expense should be included in their cost. There are, no doubt, many repairs made on the equipment where the labor of the repair man and the supplies needed are the only expenses involved. But where much supervision is needed and extensive use is made of machinery and floor space to make repairs on equipment, it seems reasonable that such work should bear its own share of burden just as tho the work were being performed for a customer.

Repairs and replacements may be the accumulated

results of ordinary wear and tear, or they may be necessary because of breakage thru carelessness or the overloading of apparatus. They are, therefore, variable in amount and should be averaged over a considerable period of time. Clearly, it is not logical to charge the entire cost of putting a new roof on a building to the particular work passing thru at that time; nor is it reasonable to charge the cupola repairs to the castings made immediately after these repairs are made. In some plants it is customary to charge the cost of minor breakages to the job by which the breakage was occasioned. This is not a good cost-finding policy for even small items. All such costs should go into the manufacturing expense and be distributed over the product.

9. *Plant ledger.*—Besides locating repair and maintenance costs by departments, an individual account should be kept with each building and machine and each group or class of apparatus the components of which are too small to list in individual accounts. Such a record is called a plant ledger. It is most conveniently formed by the card-index method as illustrated in Figure 18. A card is made out for each building or machine, and on this are recorded all repairs and all charges to the piece of apparatus. Such a card, in connection with the proper depreciation of the asset, gives a life history, and is a continuous inventory, of the asset. The entire plant ledger, therefore, constitutes a continuous inventory of the equipment and, in conjunction with the stores

ledger, the cost ledger and the stock ledger, forms a complete continuous inventory of all the material assets.

PLANT LEDGER NO. 48

MACHINE 18"x 12' Lathe	LOCATION: FLOOR 1 ROW 6
MAKER Bradford Machine Tool Co.	OUR NO. 48 MAKERS NO. 2146
PURCHASED FROM Prentiss Supply Co.	PURCHASE PRICE $1500
DATE OF PURCHASE 12-6-16	ESTIMATED LIFE 25 years
NEW OR SECOND HAND New	PROBABLE SELLING VALUE $300
WEIGHT 5020 POUNDS	RATE OF DEPRECIATION 7%

DEPRECIATED VALUE AT END OF YEAR

17	1395	00															

PLANT-LEDGER CARD (FRONT)

REPAIRS, ADDITIONS AND ALTERATIONS AFFECTING DEPRECIATION							COST OF INSTALLATION
DESCRIPTION	ORDER	DATE	CREDIT		DEBIT		FREIGHT AND CARTAGE $35
Taper attachment	3406	10-1-17	35	00			FOUNDATION $254.60
							INSTALLATION $65.20

PLANT-LEDGER CARD (REVERSE SIDE)

FIGURE 18

As before noted, only repair items which affect productive capacity are carried to the plant ledger.

All others are charged off directly to expense. Small perishable tools, such as saw blades, scrapers, and files, are usually not included in small tool accounts, but are carried under expense supplies. It is a good policy, however, to keep account of the amount of these perishable tools and supplies issued to each workman, as well as a record of all breakage of small tools and loose plant. In addition to the information thus obtained concerning the destructive proclivities of the individual workers, the very fact that a record of breakage is maintained tends to make the men more careful of costly equipment.

10. *Sundry expenses.*—In manufacturing establishments, particularly, there are many items of expense which are neither labor nor material, and which are not large enough to warrant the opening of separate accounts in the ledger. The number and amount of such items will naturally vary with the enterprise and its magnitude. Thus, gas and telephone service, which are examples of these items, may be of importance in a large works, but neither one may warrant segregation in a small plant. It is customary to group all such small items into a so-called sundries expense account. Care must be taken, however, that such accounts do not become dumping grounds for all sorts of unauthorized expenditures. All items entering into such an account should be properly authorized and vouched for, and no item should be entered therein that should logically go into any other account. Many such items will appear in the form

of bills payable from outside creditors, but all internal expenditures of this kind should be made on written authorization, and recorded and paid for only when properly vouched for.

11. *Character of general expense.*—It has been shown that general expense is logically divided into administrative expense and selling expense, tho in small enterprises this distinction is not always made. As enterprises grow in magnitude, however, this division becomes more important and these expenses should be carefully separated so that the heads of the departments concerned may be held responsible for their proper shares. In some cases where certain officials have duties that lie in both fields this may mean a more or less arbitrary division of their salaries, but even such an arbitrary division is better than none at all.

The character and classification of the expense items making up administrative and selling expense require little explanation. The classification shown in Figure 17 (page 148) is in accordance with common practice. The detail into which these expenses may be divided will, of course, vary with the enterprise. What may be a small item in one case may be a very large one in another. The majority of these general expenses will appear as bills or vouchers, tho there may be many items for which production orders may be issued and the costs carried to the cost ledger, and thence to the general accounts.

12. *Cost of welfare work.*—The above methods can,

in general, be used to account for all labor, both direct and indirect. The direct and the indirect labor expended in the actual production of goods may not, however, constitute the entire cost of compensation for labor employed. In many shops and factories large sums of money are expended to make the surroundings of the workmen more pleasant and comfortable. Such items of expense as may go into providing superior lighting and sanitary equipment can, of course, be justified on the ground that workmen turn out more and better product in pleasant surroundings than they do under the cheerless conditions common a few years ago; and the interest charges on such expenditures may justly be considered as a manufacturing expense.

But there are other branches of so-called welfare work which are concerned with the development of the workman along broad lines of general culture, and of which provision for general study and social betterment is a good example. Even tho these efforts may be justifiable, viewing the enterprise as a whole, the distribution of such expenditures should be carefully considered. It would not be wise, for instance, to charge the cost of free midday lunches, general reading rooms, summer excursions, and the like, to shop expense, if the manufacturing superintendent could not see that such things really do assist production. This is particularly true since many of the most ambitious efforts along these lines have ended in disastrous failure. Where any question arises

about the distribution of such expenditures it may be more expedient to carry them to general expense and hold the general manager, and not the factory manager, responsible for them.

QUESTIONS

Under what theory is it proper to charge taxes and insurance to expense burden?

What plan would you devise for handling the loss due to defective material?

How should engineering and development expense be distributed in cost accounting?

What is the asset value of patterns, drawings and small tools?

If the fulfilment of a contract required the purchase and installation of an expensive special machine, how should the cost thereof be treated in the accounts?

What is the correct basis for the distribution of the cost of repairs and improvements? Have these expenses any asset value?

CHAPTER XII

DEPRECIATION[1]

1. *General theory.*—In all industrial enterprises there are some assets which are fairly stable in character and which either do not change in value, or, if they change, do so only by slow degrees. Thus, the purchasing power of cash may increase or decrease but in either case it will do so slowly. The value of real estate may increase or depreciate but this change will also be comparatively slow in most cases. There are other forms of assets, however, that constantly tend to depreciate in value and this depreciation may be very rapid. For example, buildings waste away by reason of the action of the elements, as well as by the normal wear and tear that they undergo. Machinery, tools and furniture also wear out and must be replaced. Materials and supplies, worked and unworked, may depreciate to scrap value, either from the action of the elements or as a result of becoming obsolete thru changes in the art.

Such losses must be compensated for if the business is to continue and make profits. The subject of depreciation has, therefore, steadily assumed greater

[1] See also discussion of "Depreciation" in the Modern Business Text on "Accounting Principles."

and greater importance. Formerly almost entirely a matter of private interest, it has become a decided factor in the regulation of public utility corporations, and in other legal procedure. Anything approaching a comprehensive discussion of this subject is far beyond our present scope; therefore, only enough will be included to indicate its place in cost-finding practice.

2. *Capital account and revenue account.*—A careful distinction should be made between losses on capital account and losses on revenue account. If an uninsured building is burned, or if an uninsured vessel is lost at sea, the loss so sustained is a loss of capital which is in no way connected with depreciation. No allowance which the owner can make for wasting depreciation of other assets can properly be used to replace the building or the vessel. Such replacement should come out of new capital, whether it be taken from savings or borrowed elsewhere.

Suppose, however, that a company begins business with $500,000 and, at the end of a given period of time, finds that after having made allowance for wasting losses, and having suffered no losses on capital account, its assets are worth only $400,000. The company is said, then, to have suffered a loss of $100,000 on revenue or trading account. Depreciation is one of the factors that enter into, and greatly affect, loss or gain on revenue account. For, if the natural wasting losses on buildings and machinery are not provided for in the costs, and, as a consequence, the bal-

ance sheet shows a deficit when such losses are provided for, the enterprise has suffered a loss in revenue account because of this procedure. Wasting losses of this kind are a just charge against production and, as will be seen, should be included in manufacturing expenses.

3. *Forms of depreciation, wear and tear.*—The detail in which cognizance is taken of depreciation will vary widely with the enterprise. Thus, in the appraisal of public utilities where toll rates are to be fixed upon the basis of valuation the following forms of lessening value are often recognized:

(1) Wear and tear, or maintenance
(2) Physical decay, or decrepitude
(3) Deferred maintenance, or neglect
(4) Inadequacy
(5) Obsolescence.

In simpler cases less detail is necessary and these items are then grouped under two or three heads.

Under wear and tear is included the ordinary wasting away as a result of use and the action of the elements. All machines tend to wear out, the paint on buildings wears away, fences constantly break down, etc. All such wasting losses that can be compensated for by ordinary running repairs and renewals are classed under wear and tear. Under this head also may be included the results of accidents or sudden damage from unpreventable causes. The rate at which such wasting progresses will manifestly vary quite widely with the asset and the service. In

some classes of assets the fall in value may be very rapid in the beginning of service, slowing up as time goes on; while in other cases the reverse may occur, the rate of depreciation becoming greater as the asset nears the end of its usefulness.

4. *Physical decay, neglect.*—Many assets, such as buildings and machinery, even tho kept in the best of repair, will in time reach a state where repairs will no longer suffice and the entire asset must be renewed. A horse is a striking example of this form of asset. His shoes may be replaced, but no repairs or renewals can stay the gradual breaking down of his physical powers. In time he must be replaced. Depreciation of this kind is called physical decay, or decrepitude. It should be noted that depreciation because of age takes place whether the asset is in use or not. Thus buildings, boilers, insulation, etc., may waste away more rapidly when standing idle than when they are in use, and it is common experience that all properties, even when kept in good repair, eventually reach a physical state where repairs and detail renewals are no longer sufficient, and the asset must be replaced entirely.

In refined methods of appraisal, account is taken of the value of an asset, as it really exists, and the value it would have if properly repaired. Even when a plant is kept in the best of repair, it has been shown that its value must steadily decrease. If, however, repairs and renewals are neglected, the value of the asset will necessarily fall below what it would be if

kept in repair, and the amount it falls is called deferred maintenance, or neglect. Since deferred maintenance represents the amount that must be expended to restore the asset to normal condition, it is also a measure of the efficiency with which the plant has been managed, so far, at least, as its physical care is concerned.

5. *Inadequacy and obsolescence.*—Sometimes an asset must be replaced even tho it is in the best of repair, because it is no longer adequate for the work at hand. Thus, a steam crane may become too small for a growing industry, tho it may still be in good condition; or an engine may prove to be unable to drive a factory that has outgrown it, tho it may be as efficient as when it was installed. Such decreased value is known as inadequacy, or supersession, and, obviously, has no connection with wear and tear in the ordinary sense, nor is it connected with decrepitude, or decay thru old age.

An asset may become of less value because of the introduction of new methods or machines. This may occur when the asset in question is as good as new, so far as its power of production is concerned; yet the manufacturer cannot afford to be without the improved apparatus. This phase of the problem of depreciation is particularly noticeable in industries that are developing rapidly. During the early days of the growth of the electrical industry changes of this kind were many and rapid. The same difficulty was experienced in New England during the development

of the textile industry. Such lessening of value is called obsolescence; it is one of the wasting losses which is often most difficult to foresee and make provision for. Special machinery is particularly liable to become obsolescent. A factory manager should exercise careful judgment in purchasing, therefore, in order that he may not be left, at some future time, with a useless machine on his hands.

In appraising public utilities or in settling the differences of opinion between partners or stockholders and bondholders all of the above classes of wasting losses may be, and are, taken into account. It is not difficult to see, also, that sharp differences of opinion may arise between owners as to the exact disposition of these losses. But for the ordinary enterprise, where the owner is desirous of knowing only the total of such losses, it is usual to group them all under two heads, namely, depreciation and obsolescence—depreciation including wear and tear, decrepitude and neglect, and obsolescence including inadequacy also.

6. *Relation between depreciation and repairs.*—It will be clear that repairs and renewals tend to compensate for wasting losses, but from the foregoing it is also clear that in most cases complete compensation for depreciation, by means of repairs, is not possible. In large plants, consisting of many units that wear out so quickly as to need frequent and complete renewals, such compensation is sometimes possible. For example, in pottery works, where the kilns must be frequently rebuilt, it is conceivable that if there

are enough kilns the renewals may practically balance depreciation. In the case of large railways, where renewals and additions are constantly being made, it is often considered that depreciation is thus compensated for. But it is evident that in such cases there should be an obvious increase in the productive capacity of the plant to insure against gradual lessening of the assets. Even when a machine or building is kept in good repair there is necessarily, as already noted, a lessening of its productive power that cannot be stayed by repairs and renewals.

On the other hand, extensive repairs and renewals may be made on an asset, which may be considered as increasing its earning value and hence increasing its inventory value. Thus a machine may have a depreciated value of $5,000, when extensive repairs and renewals amounting to $1,000 may be expended upon it. If the producing power of the tool is thus increased it would be allowable to increase the value of the machine to, say, $5,500 and make such an entry on the plant ledger. But it should be very clear that the earning capacity has been augmented before the inventory value is raised; otherwise, the cost of the repairs should be carried to the manufacturing expense account.

7. *Relation between depreciation and capital.*—It appears from the foregoing discussion that if the capital invested is to be maintained, the wasting losses due to depreciation must be carefully and systematically compensated for. Now there is only one source

from which these losses can be compensated for, namely, revenue from output. It is a fundamental principle, therefore, that no profits should be considered until all losses to capital thru depreciation have been replaced from earnings.

This principle is very clear when applied to such enterprises as are limited in time, as, for instance, a mine. In such a case the investment is represented by the cost of the land acquired, the cost of sinking the shaft and running the tunnels, the cost of the machinery and equipment, with such cash, etc., as may be necessary to carry on the operations. When the ore is extracted the land may be valueless, and the machinery, even tho in good repair, may be equally valueless, because of its special character and the place where it is located. Obviously, the operator should sell his ore at a rate that will return to him his original investment, plus the cost of operation and plus such a profit as he can obtain on the venture. Clearly, he cannot say that he has made a profit until he has recovered his original investment and paid for all operating expenses.

One important feature of depreciation in its relation to capital is its elusive character. The general books of any concern usually give minute details regarding the changes in cash, notes receivable and material in process, but the wasting changes that take place in buildings and equipment are seldom accurately known. Furthermore, as will be shown, they are particularly difficult to evaluate, since, unlike

changes in cash and other current assets, they do not force themselves upon the attention of the accountant.

The very elusiveness of depreciation often gives rise to wide differences of opinion in cases where the enterprise is owned by several parties, and especially when both bondholders and stockholders are interested. The bondholder who is assured of a return on his investment very naturally will insist that the plant be kept in good repair, since that is necessary to insure the permanency of his capital. The stockholder, free to sell his stock at any time, is more interested in dividends, and may not object if profits are paid out of capital because of insufficient attention to depreciation. The problem, therefore, of dealing fairly with the bondholders who are the creditors and with the stockholders who should have a fair return on the stock, is intimately connected with depreciation.

8. *Original, present and scrap values.*—It may be noted in passing that the value of any asset will vary with the purpose for which the valuation is made. There is a great difference between the value of a plant viewed as a "going concern," and its value at forced sale. In appraising public utilities, for instance, several kinds of value are recognized. Thus the "service value," or the value as measured by the effectiveness of the asset at that particular time, may be considered important, since this value may be high, tho the asset itself may be old or depreciated. Again, the value of "cost of reproduction," or the value as

measured by the cost of replacing the asset with new apparatus of equal effectiveness, is often an important consideration in the appraisal of public utilities. In the usual factory inventory, however, the "original cost," "residual" or "scrap" value and the "present value," are the most important values with which the factory manager and the cost keeper are concerned.[1]

The original cost is the cost of the asset plus freight and cartage, excluding foundation and erection costs, since these are irrecoverable and should be included in preliminary expense and written off independently. Some accountants include erection costs in the original value, on the ground that they are not expenses properly chargeable to the current period, and that depreciation charges will eventually dispose of them. This view, it would seem, loses sight of the fact that the assets are thereby unduly inflated.

While it is true that such charges are, strictly speaking, a part of the investment, they are of such an evanescent character that they should be recovered as soon as possible. A machine does not change in value if moved to a new location, but the value of the outlay, incident to its erection on the original site, vanishes the instant that it is moved; while the foundation, instead of being of value is, in many cases, such as to render removal or remodeling difficult and expensive. Depreciation has to do with a different kind of lessening value, and it is much better to carry erection and foundation expenses to a suspense-develop-

[1] See also "Financial and Business Statements," p. 108.

ment account and write them off as quickly as possible.

The "residual" or "scrap" value of an asset is its estimated market value at the end of the probable producing life.

The "present value" of an asset is the value found by subtracting the total depreciation, to date, from the original cost, due allowance being made for any renewals that have been carried to the plant-ledger account of the asset.

The foregoing discussion deals with assets that are "tangible" or "visible" but, in addition to such assets, there are often others that are "intangible" or "invisible." In this class would be included the cost of preliminary surveys, legal expenses of organization, cost of franchises and patents, and other short-lived assets. Many of these may constitute a true part of the cost of the plant or be indispensable to its operation, but while extremely valuable to the enterprise as a "going concern," their actual market value may be very small. Best practice, therefore, carries all such assets to "development accounts," making provision for depreciating such accounts out of existence by means of a reserve fund. Such methods will be described in a later section.

9. *Determination of depreciation.*—All intelligent managers admit the necessity of making allowance for depreciation, but there is much diversity of opinion regarding the methods to be pursued in doing so. One of the reasons for this diversity of opinion is that

enterprises vary widely, and, in addition, it is not always expedient to make as large a deduction for depreciation as may seem desirable. An old, and still common, method is to make an annual visual inventory of every asset, the total value so obtained being the apparent inventory value of the plant. By comparison with the inventory of former years the depreciation is determined and deducted from gross profit before dividends are declared. While such a method seems practical and satisfactory for enterprises which close their books annually only, it has several disadvantages, and there are objections to its use. A visual examination may or may not be sufficient for a correct valuation of the asset, and such methods of valuation require judgment backed by long practical experience. A periodical visual examination is, however, a good check on the methods to be described, for such a visual inventory often brings to light material and apparatus that have depreciated greatly tho appearing on the plant ledger or the stores or finished-product ledger at full cost.

More advanced practice, however, provides, as has already been explained in Section 2, Chapter VI, for a continuous inventory of all physical assets, and makes further provision for definite and systematic depreciation, as indicated on the plant-ledger card shown in Figure 18 (page 167). The depreciation so determined is distributed in the factory expense and becomes an integral part of the cost of production.

10. *General method of depreciation.*—In laying

out a systematic plan for depreciating any asset it will be necessary, therefore, to know the original cost of the asset, the estimated productive life of the asset, and the probable "scrap value" of the building or machine at the end of this productive life. Some definite rate of depreciation is then decided upon that will reduce the original value to the "scrap value" at the end of the life period. It should be remembered that repairs, or renewals, or obsolescence, may make necessary some modification of the plan laid down, and it may be necessary as circumstances change, to change the rate of depreciation.

The general method of depreciating an asset may be illustrated as follows: Suppose an asset has an original value of $5,000 and when installed its estimated producing life is set at twenty years, at the end of which period it is estimated that its "scrap value" will be $500. The total depreciation which must be cared for, not considering modifying repairs or renewals, will be, therefore, $5,000 — $500 = $4,500. Suppose, now, that at the end of ten years the book value of the asset has been reduced by the method of depreciation in use to $2,000, and at that time the asset receives repairs and renewals amounting to $1,000. If such renewals bring the asset up to somewhere near the producing value of a new piece of apparatus of similar kind, it is clearly logical to increase the book value to, say, $2,500 and readjust the rate of depreciation, if desirable. On the other hand, at the end of the fifth year, the asset may be found to be in first-

class repair, but almost valueless as a producing asset, because of new inventions, or changes in processes. Thus, it is clear that the "scrap value" and the producing life depend on many factors and must, as a rule, be estimated.

There are several methods advocated, and in use, for fixing the rate at which the asset shall be depreciated from the original cost to "scrap value." This is necessarily so, since conditions vary and personal opinions govern these matters to a large degree. The three most important of these methods to be discussed at this point are percentage on original cost, percentage on diminishing value, and sinking fund.

11. *Percentage on original cost.*—Under the plan known as percentage on original cost, the total depreciation, or the difference between the original cost and the "scrap value," is divided by the estimated producing life, and the dividend is the amount set aside annually for depreciation. Thus, in the preceding example the annual depreciation would be $225. Since the same amount is deducted annually from the value of the asset the decline in value is uniform and, hence, follows a straight line. For this reason this method is sometimes designated "straight line" depreciation.

This method of depreciation has been much used because of its simplicity and because it does not make such a heavy reduction in inventory values in the beginning of the life of the asset as does the method of

percentage on diminishing value. This is an undoubted advantage for a new enterprise that has a scanty income during the early years of its existence. On the other hand, it is undoubtedly true that, with many assets, the depreciation is much greater during the early years of use than during the later years.

12. *Percentage on diminishing value.*—It is also argued against the straight-line depreciation method that it is more desirable to depreciate heavily during the early years, when repairs and renewals are not costly, and to depreciate less heavily during the later years, when repairs begin to become more burdensome. For this reason, and others, some managers prefer the method of percentage on diminishing value. Under this system a definite percentage is taken each year from the depreciated value of the preceding year. Thus, in the case already mentioned, if the rate of depreciation be taken at ten per cent, and this percentage be taken annually from the depreciated value of the year before, the same results will be obtained as with the other method. It will be clear that under this last method the depreciation will be much heavier during the early years and much lighter during the later years, for the same producing life and "residual" value than under the straight-line method. The computation of depreciation by percentage on diminishing value will be facilitated by the use of Table 1, which follows.

13. *Sinking fund.*—Some accountants use the sinking-fund method in caring for depreciation.

TABLE 1—DEPRECIATED VALUE OF UNITY AT DIFFERENT RATES FOR TERMS OF YEARS.

YEARS	1%	1¼%	1½%	2%	2½%	3%	4%	YEARS
0	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	0
1	0.990,000	0.987,500	0.985,000	0.980,000	0.975,000	0.970,000	0.960,000	1
2	0.980,100	0.975,156	0.970,225	0.960,400	0.950,625	0.940,000	0.921,600	2
3	0.970,299	0.962,967	0.955,671	0.941,192	0.926,859	0.912,673	0.884,736	3
4	0.960,596	0.950,930	0.941,336	0.922,368	0.903,688	0.885,292	0.849,346	4
5	0.950,990	0.939,043	0.927,216	0.903,921	0.881,099	0.858,734	0.815,372	5
6	0.941,480	0.927,305	0.913,308	0.885,843	0.859,068	0.832,972	0.782,757	6
7	0.932,066	0.915,714	0.899,608	0.868,126	0.837,591	0.807,982	0.751,477	7
8	0.922,745	0.904,267	0.886,114	0.850,763	0.816,652	0.783,743	0.721,389	8
9	0.913,517	0.892,964	0.872,822	0.833,748	0.796,235	0.760,231	0.692,534	9
10	0.904,382	0.881,802	0.859,730	0.817,073	0.776,329	0.737,424	0.664,832	10
11	0.895,338	0.870,779	0.846,834	0.800,732	0.756,921	0.715,301	0.638,239	11
12	0.886,385	0.859,895	0.834,131	0.784,717	0.737,998	0.693,842	0.612,709	12
13	0.877,522	0.849,146	0.821,619	0.769,023	0.719,548	0.673,026	0.588,201	13
14	0.868,746	0.838,532	0.809,295	0.753,643	0.701,559	0.652,836	0.564,673	14
15	0.860,059	0.828,050	0.797,155	0.738,570	0.684,020	0.633,250	0.542,086	15
16	0.851,485	0.817,699	0.785,198	0.723,798	0.666,920	0.614,253	0.520,402	16
17	0.842,943	0.807,478	0.773,420	0.709,323	0.650,247	0.595,825	0.499,586	17
18	0.834,514	0.797,385	0.761,819	0.695,136	0.633,991	0.577,950	0.479,603	18
19	0.826,169	0.787,417	0.750,391	0.681,233	0.618,141	0.560,612	0.460,419	19
20	0.817,907	0.777,574	0.739,135	0.667,609	0.602,572	0.543,794	0.440,002	20
21	0.809,728	0.767,855	0.728,048	0.654,245	0.587,620	0.527,300	0.424,332	21
22	0.801,631	0.758,257	0.717,128	0.641,171	0.572,930	0.511,655	0.407,349	22
23	0.793,615	0.748,778	0.706,371	0.628,848	0.558,606	0.496,306	0.391,055	23
24	0.785,678	0.739,419	0.695,775	0.615,781	0.544,641	0.481,416	0.375,413	24
25	0.777,822	0.730,176	0.685,338	0.603,466	0.531,025	0.466,974	0.360,396	25
26	0.770,043	0.721,049	0.675,058	0.591,396	0.517,749	0.452,965	0.345,980	26
27	0.762,343	0.712,036	0.664,932	0.579,568	0.504,806	0.439,376	0.332,141	27
28	0.754,720	0.703,135	0.654,958	0.567,977	0.492,185	0.426,194	0.318,855	28
29	0.747,172	0.694,346	0.645,134	0.556,618	0.479,881	0.413,408	0.306,101	29
30	0.739,701	0.685,667	0.635,457	0.545,485	0.467,884	0.401,006	0.293,857	30
40	0.688,972	0.604,622	0.546,321	0.445,701	0.363,232	0.295,711	0.195,366	40
50	0.605,066	0.533,157	0.469,689	0.364,171	0.281,988	0.218,065	0.129,886	50

TABLE 1 (CONTINUED).

YEARS	5%	6%	7½%	10%	12½%	15%	20%	YEARS
0	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	1.000,000	0
1	0.950,000	0.940,000	0.925,000	0.900,000	0.875,000	0.850,000	0.800,000	1
2	0.902,500	0.883,600	0.855,625	0.810,000	0.765,625	0.722,500	0.640,000	2
3	0.857,375	0.830,584	0.791,453	0.729,000	0.669,922	0.614,125	0.512,000	3
4	0.814,506	0.780,749	0.732,094	0.656,100	0.586,182	0.522,006	0.409,600	4
5	0.773,781	0.733,904	0.677,187	0.590,490	0.512,909	0.443,705	0.327,680	5
6	0.735,092	0.689,870	0.626,398	0.531,441	0.448,796	0.377,149	0.262,144	6
7	0.698,337	0.648,478	0.579,418	0.478,297	0.392,696	0.320,577	0.209,715	7
8	0.663,420	0.609,569	0.535,962	0.430,467	0.343,609	0.272,490	0.167,772	8
9	0.630,249	0.572,995	0.495,764	0.387,420	0.300,658	0.231,617	0.134,218	9
10	0.598,737	0.538,616	0.458,582	0.348,678	0.263,076	0.196,874	0.107,372	10
11	0.568,800	0.506,299	0.424,188	0.313,811	0.230,191	0.167,343	0.085,899	11
12	0.540,360	0.475,921	0.392,374	0.282,429	0.201,418	0.142,232	0.068,720	12
13	0.513,342	0.447,366	0.362,946	0.254,186	0.176,240	0.120,905	0.054,976	13
14	0.487,675	0.420,524	0.335,725	0.228,768	0.154,210	0.102,770	0.043,981	14
15	0.463,291	0.395,292	0.310,546	0.205,891	0.134,934	0.087,354	0.035,184	15
16	0.440,127	0.371,575	0.287,255	0.185,302	0.118,067	0.074,251	0.028,148	16
17	0.418,200	0.349,281	0.265,711	0.166,772	0.103,309	0.063,113	0.022,518	17
18	0.397,214	0.328,324	0.245,782	0.150,095	0.090,395	0.053,646	0.018,014	18
19	0.377,354	0.308,624	0.227,349	0.135,085	0.079,096	0.045,599	0.014,412	19
20	0.358,486	0.290,107	0.210,297	0.121,577	0.069,209	0.038,760	0.011,529	20
21	0.340,562	0.272,701	0.194,525	0.109,419	0.060,558	0.032,946	0.009,223	21
22	0.323,533	0.256,358	0.179,936	0.098,477	0.052,988	0.028,004	0.007,379	22
23	0.307,357	0.240,958	0.166,441	0.088,629	0.046,365	0.023,803	0.005,903	23
24	0.291,989	0.226,501	0.153,957	0.079,766	0.040,569	0.020,233	0.004,722	24
25	0.277,390	0.212,911	0.142,411	0.071,790	0.035,498	0.017,198	0.003,778	25
26	0.263,520	0.200,136	0.131,730	0.064,611	0.031,061	0.014,618	0.003,022	26
27	0.250,344	0.188,128	0.121,850	0.058,150	0.027,178	0.012,425	0.002,418	27
28	0.237,827	0.176,840	0.112,711	0.052,335	0.023,781	0.010,562	0.001,934	28
29	0.225,935	0.166,230	0.104,258	0.047,101	0.020,808	0.008,977	0.001,547	29
30	0.214,639	0.156,256	0.096,439	0.042,391	0.018,207	0.007,631	0.001,238	30
40	0.128,512	0.084,162	0.044,225	0.014,781	0.004,790	0.001,502	0.001,133	40
50	0.076,945	0.045,331	0.020,281	0.005,154	0.001,260	0.000,296	0.001,014	50

Under this scheme such an annual sum is set aside as, at compound interest, will amount by the end of the producing life to the original cost of the asset, minus the "scrap value." There are several objections to this method. First, it is unnecessarily cumbersome, mathematically; and second, as it is usually applied to ordinary depreciation, it is faulty in theory. Depreciation is an allowance for losses that have already occurred. If this loss is $200, yearly, that amount should be set aside, and not the amount which will accumulate to that value in a period of years. It will be noted, furthermore, that this method actually withdraws capital from the enterprise, and it does not seem to be a good financial policy to set aside earnings to draw interest at bank rates when, by retaining them in the business, a higher rate of interest could, presumably, be obtained. If the enterprise cannot produce earnings higher than bank interest it might as well go out of business and place all of its capital in the banks, thus avoiding, to some extent at least, the risks incident to a business venture.

14. *Typical rates of depreciation.*—The rates of depreciation will, as before noted, vary widely with the asset and the service. A single flat rate applied to all assets is unintelligent and misleading. Careful classification should, therefore, be made of all assets, and proper rates should be assigned; at the same time, the controlling factors—original cost, estimated life and "scrap value"—should be constantly borne in

mind. The rate that should be assigned to any class of asset will depend largely upon circumstances, and nothing more than suggestions can be offered here. Judgment and expediency are always important factors in the fixing of these rates. The following table, taken from the author's "Principles of Industrial

TABLE 2

ESTIMATED LIFE, AND FACTORS OF DEPRECIATION

Asset	Probable life of asset in years	Ratio of scrap to original value	Percentage on original cost	Percentage on diminishing value
Brick or steel frame buildings, easy service	40	0.10	2.25	5.5
Brick or steel frame buildings, severe service	20	0.10	4.5	11.
Good wooden buildings, easy service	30	0.10	3.	7.5
Good wooden buildings, severe service	15	0.10	6.	14.
Steam-engines	15 to 30	0.10	6 to 3	14 to 7.5
Steam-boilers	15 to 30	0.10	6 to 3	14 to 7.5
Boiler-room feed pumps	20	0.05	4.75	14.
Engine-room instruments and gauges	10	0.05	9.5	26.
Steam piping, valves and fittings	10 to 15	0.05	9.5 to 6.3	26 to 18
Portable engines and boilers	10	0.05	9.5	26.
Gas engines	10 to 15	0.05	9.5 to 6.3	26 to 18
Turbo-generators	20 to 30	0.10	4.5 to 3	11 to 7.5
Electric generators	20 to 30	0.10	4.5 to 3	11 to 7.5
Electric motors	20	0.10	4.5	11.
Storage batteries	10	0.05	9.5	26.
Switchboards and instruments	15	0.05	6.3	18.
Heavy machine tools	25	0.10	3.6	9.
Light machine tools	15 to 20	0.10	6 to 4.5	14 to 11
Shafting, hangers and pulleys	20 to 30	0.05	4.75 to 3	14 to 9
Belting	10 to 25	...	10 to 4	....

Organization," gives average rates for buildings and machinery kept in a good state of repair. These rates also include allowance for obsolescence. Corre-

sponding rates are given for the methods of depreciation which have been discussed.

15. *Depreciation a manufacturing expense.*—It should be specially noted that depreciation is a manufacturing expense and not a general expense, as it is so often considered. There is no logical justification for distributing depreciation as an even layer over the total shop costs, since the rate of depreciation varies so greatly with various assets. At the least, it should be allocated by departments in common with all manufacturing expenses, and all the arguments presented later on, looking to a still more accurate distribution of all costs, are applicable, also, to depreciation.

The amounts set aside for depreciation should, then, be distributed against production, credited in some manner to the equipment accounts and debited to the depreciation accounts. The exact method of handling depreciation reserve is a problem for the accountant and the financier. Sometimes, as has been noted, it is actually put at interest outside the business; on the other hand, it is often retained as working capital.

In conclusion, it should be remembered that mathematical methods of depreciation cannot always be rigidly adhered to. Conditions change from year to year, and the state of trade may make it desirable to modify what may have previously been an excellent practice. The all-important fact to remember is,

that depreciation is a very definite expense which must be met, and any well-defined method of determining this depreciation, even tho it cannot be absolutely adhered to, is a safeguard against a day of reckoning that might prove fatal to the enterprise.

REVIEW

How would you distinguish the following forms of lessening value:

(a) Wear and tear, or maintenance?
(b) Physical decay, or decrepitude?
(c) Deferred maintenance, or neglect?
(d) Inadequacy?
(e) Obsolescence?

Why is depreciation in the nature of an expense item and not a part of the disposition of the profits?

What are the advantages and disadvantages of the different methods of providing for depreciation? How does your comparison of these coincide with that in the text?

In your opinion would a company be wise in omitting depreciation charges in any year because this element of loss was fully covered by an appreciation in the value of fixed assets?

What is a fair estimate of the probable life of the following assets: Steel frame buildings, easy service? good wooden buildings, severe service? steam engines? heavy machine tools? belting?

How would you calculate the annual charge for depreciation of an asset by each of the methods indicated in the text? How do your conclusions check with those of the text?

CHAPTER XIII

DISTRIBUTION OF FACTORY EXPENSE

1. *General.*—From the foregoing discussion it will be clear that while the cost of direct labor and direct material can, in general, be allocated with a fair degree of accuracy to the jobs into which they enter, the problem of distributing the factory expense so that each job shall bear its share of burden is difficult and is one that seldom admits of an accurate solution. Expense items differ in their characteristics, and industrial enterprises themselves vary so widely both in size and character that it is not possible to formulate any one system of distributing expense that will be universally applicable and that will give accurate results. It should be remembered, also, that the difficulty of allocating expense grows with the size of the industry and becomes more complex as the number of lines of goods increase.

Nevertheless, it is essential that these expenses be allocated as closely as possible, especially where several lines of product are manufactured. Not only should each production order be charged with expense in proportion to the use it has made of the manufacturing facilities, but if close watch is to be kept of these expenses their distribution should show the de-

partmental responsibility for their creation. On the other hand, managers are usually opposed to complex systems and methods and are content with only a fair degree of accuracy. Nearly all cost-finding systems in use, therefore, are compromises which give approximate costs only. A number of these approximate methods are in wide use and it may be helpful to discuss briefly the characteristics and limitations of the most important ones. It will be understood also that the present discussion refers to the distribution of factory or manufacturing expense, the distribution of general expense being treated separately later on.

The basic principle of all of these methods is to use some tangible element in the job as a basis of comparison by which to measure the indirect expense which should be charged against it. It will be remembered that direct material and direct labor are tangible elements that attach themselves to all jobs in a direct and measurable fashion. The time expended upon a job is also an element that can be determined accurately, whether it be the time of the workman himself or the time of a machine which has been used. Practically all systems of expense distribution assume that one or more of these tangible elements will form a measure of the proportionate amount of expense that the job should bear. The most important of these systems which will be briefly discussed are:

(1) Distribution by percentage on material cost
(2) Distribution by percentage on labor cost

(3) Distribution by percentage on prime cost
(4) Distribution by percentage on man-hours
(5) Distribution by machine rates.

For simplicity, it will be assumed at present that these systems are applicable to the distribution of the factory expense as a whole; the limitations to this supposition will be discussed later. A more advanced and more accurate method known as distribution by production factors deserves special attention and will receive consideration.

2. *Distribution by percentage on material cost.*—In distributing expense by percentage on the material cost it is assumed that the burden varies directly with the amount or cost of the material that enters into the product. Suppose, for instance, that a machine is built involving an outlay of \$300 for direct labor, and \$100 for direct material. Suppose, further, that during the period of its construction the total expenditure in the factory for material is \$2,500 and the total expense for the same period is \$5,000. Then by this method of distributing expense each dollar's worth of material that goes into a machine should carry with it into the cost thereof $\frac{5{,}000}{2{,}500} = \$2$ of factory expenses. The expense which the job in question must bear is then $\$100 \times 2 = \$200$, and the factory cost will be:

Direct labor =	$300
Direct material =	100
Expense =	200
	$600

3. *Advantages and defects.*—It will be clear that in a simple continuous process involving the production of only one commodity, as is the case in a rail mill or a cement plant, where every part of the product makes the same use of all the facilities of the plant, the system discussed in the previous section will often be adequate. It is sufficient, in fact, in such simple cases to divide the entire cost of production by the total weight or volume of the product and establish unit factory costs that are fairly accurate. This is not because of any inherent accuracy in the method, but because, in these simple cases, allocation in a distributive sense is not necessary. All that is required is division of the expense over a uniform product. In other cases, also, where the material value entering the factory product is very large compared with the direct and the indirect labor cost, this method may be sufficiently accurate. The method is applicable also to mercantile establishments where the units handled do not vary widely in size and value, and the cost of storage, insurance, clerical assistance, etc., is fairly constant.

If, however, more than one commodity, or more than one variety of the same commodity, is manu-

factured, this method of unit costs is clearly inaccurate, unless each unit of each line of product makes equal use of all factory facilities. Furthermore, if the cost of the material is used as a basis, it is very clear that a line of goods involving expensive material will be burdened more than one in which a less valuable material is used. Thus, two pieces of jewelry may be manufactured, alike in every respect, and employing the facilities of the factory to exactly the same extent, one of them being made of gold, and one of some less valuable material—clearly, the product made of the more valuable material will be compelled, under this method, to carry more than its just share of expense.

It would be logical, again, to charge more of the foundry expense against a large casting than against a small one; but in the machine shop the large casting might have a very small amount of work done upon it, while the small one might require many hours of labor and machine work. In this case, therefore, the small casting might be entitled to a much heavier machine-shop expense than the larger one. Manufacturers using this method of distributing expense will experience difficulty in competing, in jobs involving much material and little work, against rival manufacturers using other and more logical methods.

Despite these obvious defects, however, the method is often useful and sufficiently accurate in handling such departments as foundries, and porcelain works attached to factories of the intermittent types, especially if the product of these departments is fairly

uniform in character and size, and is passed thru in large lots for stock orders. The limitations of this system are most apparent where the product is varied in quantity and size.

4. *Distribution by percentage on labor cost.*—In distributing the expense by percentage on labor cost it is assumed that the burden varies directly with the direct labor expended upon the job. Thus, with the data assumed in Section 2 of this chapter, suppose that the total direct labor for the given period is \$5,000. Then, in the preceding example the expense which every dollar of direct labor should carry into the cost of the machine will be $\frac{\$5,000}{\$5,000} = \$1.00$. The expense which the job in question must bear is therefore $\$300 \times 1.00 = \$300$, and the total factory cost will be:

$$\begin{aligned} \text{Direct labor} &= \$300 \\ \text{Direct material} &= 100 \\ \text{Expense} &= 300 \\ \hline & \ \$700 \end{aligned}$$

This result, as might be expected, differs materially from the cost obtained with material as the basis, since there is no connection between the relative amount of material and labor that enter into the product. The amounts assumed above for these items, while taken at random, are entirely probable.

5. *Advantages and defects.*—In shops where the products are closely similar in kind and do not differ greatly in size this method may, in many cases, give results accurate enough to justify its use. In justification of the method it is sometimes urged that the indirect labor varies quite closely with the direct labor, and that, therefore, the direct labor is a measure of expense. Granting that this may be true, tho it is not always so, it should be remembered that expense is composed of several other items besides indirect labor, and that these items neither are connected in any way with direct labor, nor vary directly with it. Because of its simplicity and because wages are such an important and evident part of the cost of production, this method has been, and still is, in extensive use. It has, however, serious limitations.

First, this method does not discriminate between the cost of work done by a rapid workman and the cost of work done by one less rapid. Thus, a job which takes a rapid man, receiving sixty cents per hour, four hours to complete, is burdened with the same expense as a job done by a slower man, earning forty cents, and requiring six hours of his time. This method of distributing the expense, therefore, does not differentiate between these two men in the final shop costs. Yet the slower man has employed to a greater degree the shop facilities—power, heat, lighting, floor space, tools, etc.—and, very clearly, has caused the work to cost the firm much more than it did in the case of the more rapid workman. Then,

too, because of the decreased rate of output due to the slower man, there is less total product over which to spread the expense, and each part must bear a greater proportion as the rate of production falls, since, as already explained, expense does not vary directly with product, but increases relatively as production decreases.

This method also fails entirely to differentiate between the cost of large work and the cost of small work, and the error involved in its use may become large where the size of product and the size of the machinery required, vary widely. Thus, the expense charged to a job involving labor worth $10 by a mechanic using a file only, is exactly the same under this method as that laid upon a job involving the same labor charge, but done by a very large boring mill requiring the use of much greater floor space, heating, lighting and power, as well, perhaps, as the service of a large overhead crane. The work done on a very costly automatic machine will, under this method, bear practically no expense burden, tho it is evident that the interest charge, alone, is much greater for the automatic machine than for hand work, which may bear heavy expense charges. In brief, this method of distributing expense is an *averaging* method, and fails wherever the indirect expenses vary, since it does not give accurate results in proportion to the variation in the components of the expense to be distributed.

It will be evident, however, that in shops where the

parts manufactured are of approximately the same size and character this method may be fairly applicable. The same will be true of very large plants where the volume of work is so large as to permit of careful classification and departmentization so that the work in all the departments is similar in size and character. In such cases a different percentage may be necessary for each class or department and, obviously, this departmental method will give more accurate results in plants doing mixed work than can be obtained by a flat rate on the entire product. It may be noted in passing that departmentization may not always give the desired result. If one department, for instance, is devoted entirely to generators, another to motors, and another to transformers, great differences may still exist in the size and character of parts within each department. If, however, the departmentization groups all lathes of one approximate size together, all the large boring machines together, and so on, this method is clearly more applicable. This matter will receive further attention in a later section.

6. *Distribution by percentage on prime cost.*—In the distribution of expense by percentage on prime cost it is assumed that the expense varies directly with the prime cost. Thus, using the same data as in the preceding examples, the expense which every dollar of combined direct labor and material must bear will be:

$\frac{5{,}000}{5{,}000 + 2{,}500} = \$.666$. The expense, therefore, for the job under consideration will be $(\$100 + \$300) \times .666 = \$266.67$, and the factory cost will be:

$$\begin{aligned} \text{Direct labor} &= \$300 \\ \text{Direct material} &= 100 \\ \text{Expense} &= 266.67 \\ \hline & \ \$666.67 \end{aligned}$$

7. *Advantages and defects.*—Distribution by percentage on prime cost has the same inherent defects and limitations as the methods previously discussed, since it combines the bases of both of them. Where the value of the direct labor entering into the product is small compared with the value of the material, the method approaches the plan of distribution by percentage on material. On the other hand, if the material value is relatively low, the method approaches the plan of distribution by percentage on labor. In either case there are involved the errors and limitations of one or the other of those plans.

In the general case of a factory making a varied product, as to both character and size, one piece may have a relatively high labor value and the very next one may have a relatively low labor value; distribution by this method is, in such a case, not only inaccurate, but illogical. A manufacturer doing a mixed business will find difficulty in competing on jobs in-

volving much material and little labor if his costs are based on this method. Even tho other work which he performs may justly receive a large amount of expense, the selling of a product consisting of little but material does not, in general, involve much factory expense. In fact, in the extreme case, such goods may not even enter the factory, but may pass directly from the source of supplies to the customer.

8. *Distribution by percentage on man-hours.*—In distributing the total expense by percentage on man-hours it is assumed that the expense which any piece of work should bear is directly proportional to the number of man-hours that have been expended upon it. Suppose that, as in the example already used, the total direct labor is \$5,000, and is made up of 12,500 hours of labor at varying rates. Assume also that the total expense is \$5,000 and the total material is \$2,500, as in the previous cases. Assume also, as before, that the direct material used on the job under consideration is worth \$100 and the direct labor cost is \$300; but assume, moreover, that this labor is made up of 1,200 hours of work at twenty-five cents per hour. Then the expense per man-hour chargeable against every job will be $\frac{5,000}{12,500} = \$.40$, and the expense which must be allocated to the job under consideration will be $\$.40 \times 1,200 = \$480$, whence the shop cost of the job will be:

$$\begin{aligned} \text{Direct labor} &= \$300 \\ \text{Direct material} &= 100 \\ \text{Expense} &= 480 \\ \hline & \$880 \end{aligned}$$

9. *Advantages and defects.*—It might seem at first glance that the man-hours method would give the same results as distribution by percentage on labor alone, and this would be the case if all men received exactly the same rate of wages. Thus, suppose that the total direct labor of \$5,000 consisted of 20,000 hours at twenty-five cents per hour. Then the expense chargeable against each man-hour would be $\frac{5{,}000}{20{,}000} = \$.25$, and the expense chargeable against the job under consideration would be $\$.25 \times 1{,}200 = \$300$, or the same as in the method of distribution by percentage on labor.

On the other hand, if the job under consideration received 1,500 hours at twenty cents per hour, or a total of \$300 as before, the expense allocated to it by this method would be $\$.40 \times 1{,}500 = \$600$, and the shop cost would be $\$300 + \$100 + \$600 = \$1{,}000$. Again, if it received 500 hours at sixty cents per hour, making the same total labor cost as before, the expense chargeable to it would be only $\$.40 \times 500 = \$200$, and the shop cost would be only \$600. It will be seen, therefore, that under this method the total labor cost may be the same on different jobs, but the

expense may vary widely. This method, then, takes into account the value of time spent, the factory cost decreasing and increasing with this factor. A job done by a high-priced man in a short time, and with minimum use of the shop facilities, is not burdened so heavily as one done by a cheaper and slower man who uses the shop facilities for a much longer period. This is logical, and in this respect the method of percentage on man-hours is an advance on the systems previously discussed.

The method of percentage on man-hours would seem to be more logical, in general, than that known as percentage on labor for other reasons. A great many of the principal items of indirect cost as, for instance, heat, light, depreciation, rent, insurance, taxes, interest, etc., are more fairly proportional to time than to wages or labor costs. There is no reason for assuming that the proportion of these items will be high where wages are high, and low where wages are low; in fact, such items as supervision are likely to be highest where labor costs are lowest. The interest on investment may be very high where low-priced labor is employed in operating automatic and semi-automatic machines.

On the other hand, this method is no better than that of percentage on labor, so far as differentiation between the use of equipment of different value and size is concerned. The same hourly rate is applied to a hand worker as is applied to a $20,000 boring mill. This results in overcharging small, cheap product,

and undercharging the larger and more expensive work. When applied over an entire factory which is engaged in making a wide range of work, competition with the small articles of product becomes difficult if such competition is against other manufacturers specializing in these small articles.

It will be evident that this method can be applied with accuracy only when the work is of fairly uniform size and character, but it should also be noted that the errors of this method, like those of the percentage-on-labor plan, can be obviated to some extent by careful departmentization. Where tools and processes can be grouped so as to obtain equal conditions for similar types of machinery and similar processes, this plan can often be used with success. Like the preceding systems it has the virtue of simplicity and in many cases this is no small advantage.

10. *Inadequacy of foregoing methods.*—It will be clear that under any of the plans of distributing expense that have been discussed an *averaged* result is ultimately obtained. It is clear, also, that the *total* expense can be distributed with certainty by any of these methods. None of them, however, takes account of the fact that expense does not weigh equally upon all parts of the productive activities. It is for this reason that these methods apply with some semblance of accuracy only where the conditions are more or less uniform, where the wages paid do not vary greatly, where the size and character of the equipment do not differ, and where the lines of product

are not diverse in character. In other words, where the conditions are simple, only simple methods are required. It is for this reason, also, that any of the methods that have just been discussed apply more closely when the factory can be departmentized so as to group machines and processes of similar kind and equal size together. Where this can be done, and each department is accurately charged with its share of expense, almost any method of dividing the departmental expense will give fairly satisfactory results, since each man or tool in each department is, generally speaking, equally taxable. Minute departmentization of this character is not usually possible, however, and where these simple conditions do not obtain, and accurate costs are desired, the averaging methods so far described are not applicable with any degree of accuracy.

The reasons explanatory of this fact are fundamental. When factories were smaller, and machine processes did not constitute so large a factor in manufacturing, wages or time did, no doubt, serve as a satisfactory measure of expense, especially where only rough costs were required. But neither wages nor labor hours can be taken as a measure of expense in modern factories where the product varies as to both size and character. This is markedly true where machine processes constitute a large portion of the cost of production. The elements of expense that attach themselves to a handworker may be, and generally are, very different in value from those connected

with an expensive automatic machine. The range of processes found in some modern factories is almost bewildering; so much so, in fact, that any distribution of expense by averaging methods may be little short of a wild guess, so far as accurate allocation is concerned. This complexity is still further increased when machines and processes are used intermittently in ever changing lines of product. It is true, of course, that in all complex cases a certain amount of averaging must be done, but this can be minimized and the results made more accurate than those obtained by the methods heretofore outlined.

11. *Relation between machine processes and expense.*—As a matter of fact, the majority of factory expenses do not attach themselves to labor or to material, but gather around machines and processes. Consider, for instance, the items of interest and depreciation. In the averaging method referred to, these expenses are distributed over the entire product with other items of expense, and lose their identity entirely, so far as any particular machine or process is concerned. Yet these items of expense are intimately connected with individual machines or processes and are definite parts of the cost of operation. They are not connected with the wages of the operator, since they continue to accrue even when the machine is idle. In fact this is one of the fundamental defects in using wages or labor hours as a basis of expense distribution. Many items of expense continue to accrue even when no wages are being paid and the factory is closed

down. It is not logical that an article produced by hand labor should be allowed to bear a portion of the expense equal to that borne by a part machined on a large boring mill; yet this is just what the averaging methods accomplish if they are applied over diverse product of varied size. Similar reasoning applies to such expenses as heat, light, power, insurance, rent, taxes, repairs, and in fact to the greater part of shop expense.

It should be remembered also that the amount of these expenses may be very large. Shop expense frequently amounts to 100 per cent, and sometimes goes as high as 150 per cent, of the direct wages. It is fully as important that this expense be accurately allocated as that the labor cost be correctly recorded. This is particularly true where it is desired to know the cost of different sized articles or different lines of goods, with a view to meeting competiton on a correct basis.

12. *Old machine rate.*—When, therefore, the traditional influence of wages and labor hours is once discarded, it becomes clear that many of the items of expense are naturally connected with the use of equipment of one kind or another. Rent, insurance, taxes, interest and depreciation are connected with the use of buildings and machines. Heating, lighting and power are likewise connected as much with machines as with men, and if costs are to be intelligently applied this factor must be taken into account. This aspect of cost finding was recognized in mixed manu-

facturing many years ago, and so-called machine rates have long been in use. In fact, the conception is a very old one and had its origin, no doubt, in an instinctive effort to discharge the interest on investment and wear and tear of the machine, in a degree in some proportion to its size and cost. This effort probably was a natural result of the growth in the variety and size of machines.

In its original form the machine rate made no effort to insure accurate allocation of the total factory expense, but attempted rather to equalize in some degree such items of expense as clearly attached themselves to machines and processes; it perhaps took into account the probable life of the machine. All machines and processes were divided into a few classes designated often by letters or numbers. A graduated hourly rate was then assigned to each class, and each piece of work done on every machine was taxed accordingly, and in proportion to the time during which it made use of the utility concerned. In most cases, by some averaging method an additional expense charge was added to the factory cost so determined; the profit which was added was sufficient to cover all discrepancies. This method, which might be said to belong to the "stone age" of cost finding, is not to be recommended. It is of importance, however, because of the principle involved.

13. *Modern machine rate.*—As the need for more accurate costs grew, it was a most natural tendency to extend the method to cover handwork as well as

machine processes. Under such systems the hourly burden imposed on the work for the services of a skilled handworker might be forty cents per hour, while the hourly rate for a large machine tool might be $5 per hour. Furthermore, as the need for accurate costs became still more important, it was also natural to extend this system so as to distribute the total factory cost, if possible. The fundamental principle, then, in the modern machine rate is to assign to each machine its own share of expense for a given period of time. This total expense is then divided by the estimated number of hours that the machine or process will be in use for this same period; this estimate, of course, is based on previous records or some similar source of information. The dividend so obtained is the hourly rate which must be applied to each job using the tool or process. It is clear that a close and proportional allocation of all expenses will be accomplished if each tool and process is in operation during the exact time which has been estimated, and if no additions or deductions are made to the equipment and working force during the period considered. It should be noted that in using this method a machine, in this sense, will be any machine or process from a vise to the largest tool. In fact, as will appear presently, allocation may be made, in this manner, to any place where the work of men involves the use of expense items. The idea underlying this method, therefore, is to measure off *directly* to each "machine," as thus defined, its own share of expense, basing this

measurement on the use each machine makes of the several expense utilities, and not on some arbitrarily chosen standard, such as wages or material, which is in most cases only remotely connected with the measurement of these expenses.

14. *Advantages and defects.*—Viewed simply as a means of equalizing interest and depreciation, the simple machine rate may justify its use in some instances; but as ordinarily used as a means of distributing the total expense, it is greatly inferior to the averaging methods already discussed, so far as accuracy is concerned. It will at once be recognized that the allocation of all expenses by machine rate necessitates considerable preparatory work. In a large factory composed of a number of buildings, each building containing machines and processes similar in size and kind, an intelligent allocation of many expenses could be made to each department, and these departmental expenses could easily be distributed by machine rate if certain other difficulties, to be discussed later, could be properly dealt with. For in such a case the departmental expense could be accurately allocated to the building as a whole, and each machine, theoretically, should share equally in this burden. Such conditions are, however, rather rare and it is difficult, if not impossible, in most cases, to secure these conditions by rearrangement of the equipment. In a small factory, where there are few tools of each size and kind, and where the processes are varied, a considerable difficulty may arise in justly allocating the

expense chargeable to each utility. But even in factories of this type it is possible to make a fairly consistent allocation of a large portion of the burden.

It should be noted that, altho a large part of the expense naturally gathers around machines and processes, there are other expenses that do not naturally so attach themselves. Thus, general labor and supervision, crane service, transportation service and similar expenses, are not so clearly assignable by machine rate and may need some form of special determination. But all of the above objections can be more closely met than can the inherent defects of the averaging methods. As will be shown, it is possible, even in complex cases, to work out a machine rate that will be obviously more intelligent than any averaging method. Whether in any particular case it will be expedient, and whether it will pay to do so, will, of course, depend on the immediate circumstances. There is, however, one fundamental defect of the simple machine rate which destroys its accuracy unless special precautions are taken.

It will be remembered that the hourly rate is established by estimating either upon the basis of past experience or upon that of the probable number of hours the machine or process will be in operation during the period considered. Obviously, the accuracy of the hourly rate will depend on how closely the actual operating time of each machine corresponds with the estimated time. Should a machine be in operation more than its estimated time, as might occur

in overtime work, due to a hurry job, an overcharge of expense is made. On the other hand, should the machine fail to operate the full estimated number of hours because of lack of work or a breakdown, an undercharge of expense will be made. It may happen, of course, that these two errors will balance each other, but in general they will not, and there is no definite way of knowing just what the error is. When the volume of work is decreasing, the large machines become idle first; this may lead to a serious undercharge which cannot be detected until it appears in the general accounts, too late, perhaps, to remedy the difficulty. Furthermore, it is not possible, as a rule, to estimate in advance just how long any machine will be in operation, even when the records of past performances are available. It is not always possible to wait until the end of the month to find out how long each tool has been used; so that, in general, the estimate of the operating time of any tool or machine must be approximate. The simple machine rate as outlined depends, therefore, for its accuracy on the constancy of all factors, a condition which seldom, if ever, occurs.

Notwithstanding these serious defects, which eliminate the simple machine rate from most of the modern systems, this method possesses one characteristic which is possessed by no other system and which has not only been the means of keeping it alive, but which also promises to make it more important in the future. The machine rate does take into account the

difference in the cost of work done on machines of different sizes and by different processes. Some of the relations which it establishes between the machine or process and the work done, are fairly permanent and do not vary with the volume of business transacted. For this reason it probably forms a better basis for a cost system than any other plan.

15. *Supplementary rate.*—Numerous expedients have been proposed to make the machine rate more effective. Space will not permit a discussion of all the propositions; in fact, most of them are not important enough to merit much discussion. The latest and, in all respects, the most comprehensive effort to adapt the machine rate to modern conditions is that of Mr. A. Hamilton Church. Mr. Church has endeavored to make the machine rate more serviceable by the use of a so-called supplementary rate, the operation of which will now be briefly described. All expenses which can be so allocated are apportioned to machines and processes proportionally. These allocated expense items are charged off by a machine rate, as already described. A record is kept of all such expense so distributed and at the end of the month, or whatever other period has been selected, the total sum of this distributed expense is subtracted from the total shop expense which has accrued during the period. The difference so obtained is, of course, the expense which remains to be distributed; it represents the expense which has not been distributed by machine rate, owing to idleness of the machines, plus all other

general shop expenses which cannot be allocated to machines or processes. If all machines and processes have been in operation the exact time used in estimating the machine rate, the undistributed expense will, obviously, consist entirely of general shop expenses. Whatever the content of this residual expense, it is either charged off by one of the averaging methods that have been described over the jobs that have gone thru during the period, or it is distributed as a percentage on the expense already apportioned to those jobs by the machine rate.

Theoretically at least, this method makes the most intelligent allocation of the bulk of the expenses, and with this supplementary rate the total expense will be distributed with as much certainty as by the averaging methods. The supplementary rate serves also as an index to the volume of work in the shop. A rising supplementary rate would indicate lack of work, while a falling rate would indicate reverse conditions. In principle, at least, the machine rate, with the supplementary rate, offers an attractive solution to one of the most difficult problems of cost finding.

It will be obvious, also, that in many cases approximate machine rates can be assigned without great difficulty. In the general case of mixed manufacturing, however, the assigning of the machine rate requires considerable preliminary work, if any approach to accuracy is to be obtained, and this weakness constitutes the greatest defect of the method. Mr.

Church's plan is so logical, however, that it is discussed more fully in the succeeding chapter.

REVIEW

Why is the question of the distribution of expense burden important?

Using your own figures, how would you distribute expense burden under the following methods:

(a) Distribution by percentage on material cost?
(b) " " " " labor " ?
(c) " " " " prime " ?
(d) " " " " man-hours " ?

What is the inherent defect in all of the above methods, and to what class of enterprise may each method be applied without serious error?

What is the difference between the old and the modern machine rates? What do you understand by the supplementary rate?

What, in your opinion, are the principal defects of these methods of burden distribution?

CHAPTER XIV

PRODUCTION CENTERS AND THE SUPPLEMENTARY RATE

1. *General principles.*—The method of distributing expense by the machine rate and the supplementary rate has come into prominence thru the writings of Mr. A. Hamilton Church,[1] who has investigated the plan very thoroly, and whose reasoning presents a somewhat different point of view from that upon which the old averaging methods are based. As a result of this reasoning the shop or factory, instead of being regarded as an organized whole, as in the averaging methods, is regarded as "a collection of production centers, each differing from the other, with certain common connecting bonds," which are the averaged or general factors in the expense charge.

As Mr. Church explains:

A production center is, of course, either a machine or a bench at which a handicraftsman works. Each of these is in the position of a little shop carrying on one little special industry, paying rent for the floor space occupied, interest for the capital involved, depreciation for wear and tear, and so on, quite independently of what may be paid by other

[1] See "The Proper Distribution of Expense Burden," by A. H. Church; also "Production Factors in Cost Accounting and Works Management," by the same author.

production centers in the same shop. Then, in addition to this, there will be a separate debit representing those items of expense which can be treated only as an average all-round charge.

2. *Production centers illustrated.*—This conception will become clearer if the factory be regarded as consisting of a large number of small productive units, separated physically from each other and supplied with heat, light and power from a central station in such a way that all such services can be measured and debited against each little shop. These little shops will necessarily vary in size and in the size and character of their equipment.

If, now, the owner of this factory should rent some of these little shops to employes and should operate others himself, he would not charge off the operating expense by any system of averaging. He would, necessarily, keep an independent account with each production center so as to be able to show the exact amount of each service (or production factor) that he supplies to each shop. Some of these services, such as insurance, depreciation, taxes and supplies, could be accurately recorded and charged to each center. Others, such as heat, light and power, could not be charged with quite the same accuracy, but still with accuracy enough for all ordinary purposes. Other items of general service, such as transportation and telephone service, might give still greater trouble; yet a fair approximation could be made even in these cases. And lastly, there might be a small residuum

of expense, so general that it might have to be distributed by some averaging method.

The workman renting one of these little imaginary shops would then receive a periodical statement of his indebtedness to the owner. He could add thereto any other expenses peculiar to his work and, by estimating the number of hours during which his machine was in operation, he could compute a machine rate that would discharge all of his expense in the manner already described. By means of a supplementary rate, as previously explained, he could also care for any other expense which could not be controlled in this manner, and also for the difference between the actual and the estimated number of hours during which his machine was in service.

3. *Application to actual conditions.*—It would seem that these conditions do not change simply because the imaginary walls are taken away from these little shops and a large building, housing them all, is erected over them. Mr. Church's argument that this method is the only accurate one of finding costs seems logical. The possible functions of a manufacturer are numerous. He may be an owner or he may be a renter. He may supply his own power or he may buy it. He may furnish his own heat and light, or he may depend on others for these services. Viewing the manufacturer from this standpoint, it is clearly more logical to segregate his expenditures according to functions than it is to segregate them according to the kinds of workmen employed. The workman who rents one

of the little shops discussed above, will be interested, for instance, in the cost of power per kilowatt as measured by his meter, and will not be interested in the average cost of repairs to the entire factory of which the power plant forms a part.

An analysis of all labor expended in a given time, arranged according to the kinds of labor employed, does not, in general, give as intelligent a view of what has occurred as an analysis arranged to show the results of the several activities or functions of the business. There does not seem to be any reason why the manufacturer should not know the unit cost of his power, no matter whether he buys it or produces it himself.

It will be seen, therefore, that the general idea of classifying and distributing the expense according to the functions or activities of the business is decidedly different from that which lumps all expenses together and distributes them uniformly over the entire product. The first classifies all expenses that apply to each activity or service of the business in such a way that this service and its efficiency, or inefficiency, stand clearly revealed. The second and older method throws into one lump all expense of a given kind, without regard to the service rendered, and at best gives nothing more than comparative totals which may or may not be useful. This may be made clearer by considering the problem a little more concretely.

4. *Production factors.*—In discussing the concrete case of an actual factory Mr. Church classifies the pro-

duction factors, or services rendered to production centers, as follows:

a. Land-building factor.
b. Power factor.
c. Lighting factor.
d. Heating factor.
e. Organization factor.
f. Supervision factor.
g. Stores-transportation factor.

These are general factors that serve production centers in varying degree, according to their needs, and they are, in general, the most difficult to allocate. In addition, each center will have certain expense factors which are peculiar to itself, and which arise out of the character of the production center and the work therein performed. These include such items as interest, depreciation, repairs, supplies and all other expenses which obviously are entirely of a local character, and which belong strictly to the production center concerned, bearing no relation to any other machine or process. It remains to consider the practical distribution of these several factors to the various centers. This feature of the plan is here discussed in order to bring out clearly the general principles involved and to show the difficulties to be encountered.

The first step in arranging this system is to lay off the factory into production centers. These centers may include no tools at all, or they may include only one tool, as in the case of the large machines, or they may contain several, as in cases where a number of tools exactly alike are grouped together. The entire

factory must be mapped out in this manner in order that all equipment may be accounted for.

5. *Land-building factor.*—The first factor to be considered would probably be the land-building factor, and the first item under this heading would naturally be the rental of the ground on which the building stands, or the equivalent interest on the investment in the land, if it is owned by the proprietor. To this would be added the rental of the buildings (or the equivalent interest if they are owned outright), and the taxes, insurance, repairs and depreciation on them. The total of these charges divided by the total productive floor area would give the charge per unit of floor area which must be made against each production center.

In making such computations it may be necessary to take into account the use to which different floor areas are put. Thus, space in a high building used for erection purposes, and served by an overhead traveling crane, will be more valuable than the floor space of an adjoining building where three or four floors are used. This difference can be compensated for by charging a higher rate for the floor space in the high-roofed shop in computing the unit space charge as outlined above, and also in computing the total space charge for the high-roofed shop.

In some cases the buildings cover only a small part of the land, the remainder being used for storage or other useful purposes directly connected with the business; or part of the grounds may be used in an

ornamental way for lawns and parks. Again, the ground may be held under still different conditions. Part may be owned outright, part may be mortgaged, or part may be leased. Obviously, no definite rule can be laid down that will cover all cases, so each must be handled according to the conditions existing. In all cases, however, the land-building factor may be measured in terms of floor area.

6. *Power factor.*—The distribution of the cost of the power used may be very simple, or it may be complex. If electric power is purchased and each machine has its own meter, it would not be difficult to apportion the power cost with accuracy. But in the average factory such simple conditions seldom exist. The same set of boilers may furnish steam for operating engines which supply power to the factory, to hydraulic pumps which supply an hydraulic system, and also to air compressors which supply a pneumatic system.

The transmission system may be complex, and it may be difficult to separate its services by departments unless the system has been constructed with this end in view. In addition, a large amount of power may be used in testing new product, as in the case of factories making electrical machinery.

But even in complex cases a division of the total power supplied can be made in a satisfactory manner, tho it may not be absolutely accurate. Evidently, in very complex cases some estimating must be done; the total output of power of any kind can

then be debited to the several centers using it, in proportion to the capacity of the motor or belt which operates it.

As before explained, an estimate must be made of the time each center will be in actual operation. The product of this estimated time and the horsepower assigned to each center gives the horsepower hours which each center is expected to use. The total horsepower hours developed, divided into the total cost of the power, will give the rate per horsepower hour that must be used in distributing the power expense. The total cost of any one kind of power must include depreciation, repairs, fuel, etc., and the interest on that part of the power plant which supplies the power.

7. *Lighting factor.*—The general method of apportioning the lighting expense would be similar to that pursued for the problem of power, in so far as allocating the total cost to any one building is concerned. The total cost of lighting that is assigned to any building, divided by the total floor area of the building, as in the case of the building factor, will give the total charges per unit of floor area, and the amount that would belong to each production center may be found by multiplying this unit charge by the floor space assigned to the center. Due care must, of course, be taken that interest, repairs, depreciation, etc., over the entire lighting equipment are equitably distributed to each building so far as possible, as well as that the actual cost of the gas or electricity supplied is accurately estimated.

8. *Heating factor.*—The problem of heating and ventilating is very similar to that of lighting, the cost being reduced to a charge per unit of floor area. These items, as in the case of lighting, are not constant the year round. Thus, heating may be required during only a few months of the year. It would not be good policy, however, to charge off these heavy expenses during the months they are incurred. The total cost of heating and ventilating the factory is, therefore, spread out over the entire year, lighting being treated in a similar manner.

It would appear, therefore, that even in this method of distributing expense, some averaging must be resorted to; exact distribution in point of time would not be desirable. It should be noted, however, that this averaging is within the service itself. It simply equalizes the service charge over a period of time, differing in this respect from the old averaging methods, which average all services over all activities, regardless of the use each activity has made of such services.

9. *Organization factor.*—Under the term organization factor, Mr. Church includes such elements as the building factor of offices, cost of time and cost keeping, factory office expenses, wages of watchmen, interest, and depreciation and repairs on office furniture and fixtures. There is no difficulty in obtaining the yearly and monthly totals of these items, and it only remains to assign this total by machine rate.

In a very large establishment which is highly depart-

mentized this total could be apportioned to the several departments with a fair degree of accuracy; but after such an apportionment is made for a large plant, and always in the case of a small factory, further allocation, based on services rendered, would be difficult. It is sufficiently accurate, however, to distribute these departmental totals by simple division over the production centers involved. The cost of this class of service is not, in general, affected by the size or weight of the parts handled. It costs as much to put in a production order for a small part as it does in the case of a large one. This method will, therefore, be substantially correct. The dividend obtained by dividing the total organization expenses by the number of production centers involved, will give the factor which may be included in the machine rate to cover these expenses.

10. *Management and supervision factor.*—The management and supervision factor will include the wages of superintendents and foremen, cost of inspection, the building factor of such offices as pertain to supervision, and the interest, depreciation and repairs incident to the equipment involved. Brief reflection will show that there is no fixed or best way for allocating this expense; the method used must vary with the circumstances. In other words, the element of judgment must enter into the distribution of this factor. Many of the items can be localized without trouble, and when this has been accomplished the remainder should be distributed after a

careful survey has been made of the relative value of the services which they have rendered.

11. *Stores and transportation factor.*—The last factor, stores and transportation, is by far the most difficult to apportion. This factor will include the cost of storing, handling, and transporting material during manufacture. It will not include freight and cartage of finished product, or such items as the handling of coal and ashes, which belong in the power-house accounts.

Mr. Church has pointed out that the storing of materials, moving them from stores to shops, and from machine to machine, constitutes a separate and distinct service that should be accounted for separately and charged for in proportion to services rendered. It is true, also, that the efficiency of the factory is measured largely by the efficiency of the system of stores and transportation; hence comparative costs on this class of service would be valuable, aside from their use in cost finding. Mr. Church has also noted that this factor is divisible into two parts—the cost of storing materials and the cost of moving materials. It should also be observed that the allocation of this item cannot be made on the basis of the value of the materials handled unless the material is all of one kind. It costs no more to handle brass castings than it does to handle wooden articles. Bulk or weight must be the basis for such allotment.

Furthermore, it can be easily seen that there is no fixed rule or method by which this apportioning

can be accurately accomplished; it is principally a question of judgment. In a shop doing mixed work in an intermittent manner very accurate allocation of this item is impossible.

In this item, however, if due care is taken, the cost of the general stores can be allocated to departments, the cost of the transportation service can be localized as far as possible, and the items of general utility can also be apportioned as good judgment may dictate. Even such a disposition of these expenses will be fairer than that obtained by the averaging method, which taxes all activities equally. When the totals have been allocated to each center, the amount chargeable against each can be reduced to an hourly rate and included in the machine rate as before.

12. *Individual factors.*—In addition to the general factors that have been discussed there will be, as has been noted, certain expenses that are directly connected with each production center itself, and which have no connection whatever with other centers. Thus, repairs, interest on the value of the machinery, depreciation, insurance, and such supplies as may be necessary for operation, may be mentioned as examples of these individual factors. In some cases the cost of tools or attachments might be included in this charge. Obviously, the totals of these items can be reduced to an hourly charge which can be included in the machine rate. The relation between depreciation and repairs requires no further comment except to point out that a careful distinction should be made

between repairs that add to the producing value of the centers and those that simply replace wear and tear.

13. *Controlling accounts.*—It will be evident that some means must be provided for insuring that the total cost of each service is properly distributed as the expenses rise and fall, and that the supplementary rate absorbs the residue. In all averaging methods the same care must be exercised with regard to the totals of all expenses. To accomplish this, Mr. Church advocates the use of control accounts, an account being kept for each factor. All accruing expenses of a given kind are carried to the proper control account and placed on the debit side. All expenses distributed are placed on the credit side. The difference, if any, indicates the change which must be made in the machine rate to obviate discrepancies. Clearly, such controlling accounts can be used with advantage for equalizing heavy expenses over definite periods of time.

14. *Assembling of production factors.*—The foregoing discussion of production factors is based largely on Mr. Church's reasoning, and is introduced particularly to show the character and the difficulty of the problem rather than to offer specific methods of solution. It may be well, however, to note some methods for collecting these factors into concise and usable form. Evidently the problem is complex and should be undertaken systematically. Figure 19 shows a form suggested by Mr. Church,[1]

[1] See "Production Factors," by A. Hamilton Church, p. 128.

and arranged for the convenient collection of these items. A schedule like this may be provided

SCHEDULE OF ____________ AND MACHINE RATES | SHOP FACTORS

					SHOP TOTALS PER ANNUM
1	DESCRIPTION				
2	MACHINE NO.				
3	SPACE OCCUPIED				
4	POWER ABSORBED				
5	CAPITAL VALUE				
6	DEPRECIATION RATE				
7	BUILDING FACTOR				
8	POWER FACTOR				
9	LIGHTING FACTOR				
10	HEATING FACTOR				
11	STORES-TRANSPORT FACTOR				
12	SUPERVISION FACTOR				
13	ORGANIZATION FACTOR				
14	INTEREST, DEPC'N & INSR'CE				
15	REPAIRS & MAINTENANCE				
16	OIL AND ALLOWANCE				
17	TOOL ROOM CHARGE				
18	YEARLY TOTAL FOR 2700 HRS.				
19	HOURLY RATE				

FIGURE 19—SCHEDULE FOR DISTRIBUTING EXPENSE ACCORDING TO PRODUCTION FACTORS

for each shop or department, and there should be a vertical column for every production center in the shop. The total hourly rate then may be found for

each center by dividing the total of all charges by the total hours of operation.

While comprehensive, so far as the detail is concerned into which the production factor idea is carried, this form is arranged for recording the final values only and does not assist materially in actually computing these values. An examination of Figure 20 may be of service, therefore, in the application of the foregoing methods. Figure 20 shows a hypothetical analysis of this problem, made by Mr. Sterling Bunnell[1] and reproduced from his work on "Cost Keeping," with minor changes to make its discussion clearer. The example selected is drawn from a small shop, with one high story housing the larger tools, and an adjoining two-story building housing the smaller tools. The high story is equipped with a traveling crane. Mr. Bunnell illustrates several good approximations and other means by which the detail of the method may be shortened without materially affecting its accuracy. A brief study of this tabulated statement will make the possibilities of the method more real.

In the table, the first column, reading from left to right, contains the number of the production center. This number may be attached to the production unit in any convenient manner that will make identification sure and easy. The second column contains the name and the size of the unit. The third and fourth columns contain the single-story and two-story floor

[1] See "Cost Keeping," by Sterling Bunnell, p. 152.

Number	NAME OF UNIT	SQ. FEET One-Story Space	SQ. FEET Two-Story Space	Value in Place	Estimated Years	Estimated H. P.	MONTHLY Hrs.	H. P. Hrs.	Insr. Depr. Intr.	Space Charge	Power Heat and Light	Repairs to Machinery	Repairs to Small Tools	General Labor and Supplies	Total	BURDEN (Cents per Hour) Exact	Supp.	Assigned
1	Lathe 18″ x 10″	120		$600.00	15	1	240	240	3.33	1.32	7.20	.50	3.00	10.00	25.35	.105	Other expenses 3c per hour, on 8930 hours-$267.90	.20
2	" 24″ x 14″	152		900.00	15	1½	200	300	5.00	1.67	9.00	.75	5.00	10.00	22.42	.112		.20
3	" 32 Chucking	320		3,200.00	10	5	180	900	26.66	3.52	27.00	4.00	25.00	50.00	136.18	.756		.80
4	Cylinder Borer		240	1,800.00	15	3	200	600	10.00	5.28	18.00	2.00	10.00	20.00	65.28	.326		.40
5	Radial Drill 48″		160	900.00	12	1½	240	360	6.25	3.52	10.80	.50	5.00	20.00	46.07	.192		.20
6	" " 72″		192	1,300.00	12	2	200	400	9.03	4.22	12.00	1.00	7.50	20.00	53.75	.269		.40
7	Heavy Upright Borer		192	800.00	12	2	200	400	5.55	4.22	12.00	1.00	5.00	20.00	47.77	.239		.40
8	Lathe 32″ x 16″		207	1,700.00	18	5	150	750	7.87	4.55	22.50	1.00	7.50	10.00	53.42	.356		.40
9	Open-Side Planer		358	3,700.00	20	7	200	1,400	15.42	7.88	42.00	2.00	10.00	20.00	97.30	.487		.50
10	Boring Mill 72″		266	3,000.00	20	5	180	900	12.50	5.85	27.00	2.00	5.00	30.00	82.35	.457		.50
11	" " 30″		126	1,200.00	15	3	240	720	6.66	2.77	21.60	1.00	5.00	10.00	47.03	.196		.20
12	Hor. Slab Mill		161	1,300.00	10	5	200	1,000	10.83	3.54	30.00	1.00	20.00	30.00	95.37	.477		.50
13	Assembly 8 Men		2,323	400.00	2	5	1,950	1,250	16.66	51.10	37.50	2.00	25.00	100.00	232.26	.170		.20
14	Patt. Shop 2 Men	600		2,100.00	15	1	500	500	11.66	6.60		1.00	4.00	25.00	48.26	.096		.20
15	Turret 2″ x 24″	216		1,400.00	10	2	220	440	11.66	2.38	13.20	2.00	10.00	40.00	79.24	.359		.40
	2″ x 24″	216		1,400.00	10	2	220	440	11.66	2.38	13.20	2.00	10.00	40.00	79.24	.359		.40
16	Screw Machine	150		500.00	10	1	240	240	4.17	1.65	7.20	1.00	7.50	20.00	41.52	.173		.20
17	Fox Brass Lathe	130		400.00	10	½	100	50	3.33	1.43	1.50	.50	2.50	5.00	14.26	.143		.20
18	Drill 30″	110		200.00	15	1	240	240	1.11	1.21	7.20	.50	2.00	5.00	17.02	.071		.20
19	" 30″	110		200.00	15	1	240	240	1.11	1.21	7.20	.50	2.00	5.00	17.02	.071		.20
20	Lathe 16″ x 8″	160		400.00	15	1	240	240	2.22	1.76	7.20	.50	3.00	5.00	19.58	.082		.20
21	" 16″ x 10″	180		450.00	15	1	240	240	2.50	1.98	7.20	.50	3.00	5.00	20.18	.084		.20
22	" 24″ x 8″	240		850.00	15	1½	220	330	4.72	1.98	9.90	.75	5.00	10.00	32.35	.147		.20
23	Miller No. 4 Univ.	144		1,050.00	12	2	200	400	7.29	2.84	12.00	1.50	10.00	15.00	48.43	.242		.40
24	" No. 2 "	144		700.00	10	1	240	240	5.83	1.58	7.20	1.50	10.00	15.00	41.11	.166		.20
25	Shaper	180		700.00	15	1½	200	300	3.88	1.98	9.00	.50	2.50	10.00	27.86	.139		.20
26	Vises 6 Men	1,000		300.00	2	2	1,450	500	12.50	1.00	15.00		15.00	50.00	109.50	.071		.20
	TOTALS						8,930					31.50	219.50	600.00	1,589.12		267.90	
	Power-Plant	1,100		2,600.00	20				10.42	12.10		8.00		360.00	390.52		2.87	.03
	Tool Room	780		3,000.00	15				16.66	8.58		3.00		185.00	213.24			
	Total Working Space	6,052	4,225															
	Total Depr. & Sp. Charge								246.48	150.10								
	Total H. P. Hours and Cost					64½		13,620			408.60							
	COLUMN NUMBER	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

FIGURE 20—BURDEN-DISTRIBUTION TABLE

space allocated to each production center. The fifth column gives the value of the equipment in each center. The sixth column gives the estimated life of the asset, taking obsolescence into account. Column seven gives the estimated average horsepower required to operate the unit, while column eight gives the estimated number of hours during which the machine or production center will be in use during the month. These latter values must, of course, be established by estimate unless means are provided for measuring the power consumed over a considerable period of time; but if estimated, their total should check with the total power developed. Column nine gives the horsepower hours used by each unit found by multiplying together the corresponding values found in columns seven and eight. Column ten contains the charges for interest, depreciation, and insurance. In Mr. Bunnell's original example, only depreciation is given in this column, interest and insurance apparently not being included in the analysis. From the discussion, however, it will appear that these and similar items should be included in exactly the same manner as depreciation. The values given in column ten are those listed by Mr. Bunnell for depreciation alone and would, therefore, be too small if interest, insurance, taxes, etc., were included. They will serve, however, to illustrate the principle.

The unit space charge, column eleven, is found by dividing the interest on the building and ground, or

the rent charge for them (in this case taken at ten per cent on $18,000, or a total monthly charge of $150), by the total area, after doubling the area of the high-story building. This gives 1.1 cents per month per square foot of space for the low-story floors and 2.2 cents for the high-story. Multiplying the areas in columns three and four by the proper respective rate gives the values shown in column eleven.

Power, heat and light, column twelve, are all considered together, and this seems logical in the case of a small shop. The total expense of these items, including space charge, depreciation, etc., divided by the total horsepower hours developed (see bottom of columns nine and twelve), gives the cost per horsepower hour as three cents, nearly, and multiplying the items in column nine by this rate gives the amounts listed in column twelve.

Columns thirteen, fourteen and fifteen list the respective items of repairs to machinery, repairs to small tools and general labor and supplies that are chargeable against each center. These items can be allocated by judgment until such time as accurate records can be obtained, care being taken that the total of each kind of expense is covered by the allotment. In small shops these items can, no doubt, be apportioned accurately enough by judgment.

The totals of the items in columns ten, eleven, twelve, thirteen, fourteen and fifteen opposite each unit, are then totaled and carried to column sixteen. These totals in column sixteen represent the monthly

cost of operating each unit. Dividing corresponding items by the estimated number of hours of operation gives the hourly rates listed in column seventeen. All remaining items of expense not provided for are converted into a monthly total and divided by the total hours worked by all productive units, giving a rate of three cents per hour for every production hour, as indicated in column eighteen. This supplementary amount, added to the corresponding items in column seventeen, gives the total burden rate which should be charged for the use of each productive unit.

It is evident that these rates are only approximately accurate. It will be logical and much more convenient, therefore, to express them in even figures. Furthermore, it will be more convenient if all rates which are nearly alike are grouped together and an average rate taken for the group; in this manner the number of rates is reduced. This has been done in the above example, and column nineteen gives the final readjusted rates. It will be noted that some of the smaller rates have been increased to make them carry a little more of the burden, and all rates have been rounded off so as to make computations simpler, and also so as to make as few groups of rates as possible. If it is desired, these groups may be designated by letters and each unit may be given the letter corresponding to the group in which its rate is found. The time cards sent in from each center may then bear the letter identifying the rate assigned to it; in this way the computation of the expense charge-

able against each job is greatly facilitated. The operation of the plan then becomes identical with the operation of any machine rate with the supplementary rate, but obviously the results produced are much more intelligent. This illustration, while it does not possess the refinements of the complete plan as outlined by Mr. Church is very useful in showing how the method may be modified to suit small shops, or other plants, where a compromise must be made. With all the modifications and approximations suggested it is evident that costs obtained by this method will be much more equitable than those obtained by the averaging methods.

15. *Defects of and objection to production factors and supplementary rate.*—The manifest advantages of this method are offset, to some extent, by the great amount of preliminary work and study necessary to instal the method in plants of large size or complex character. If the plant is built and laid out with the cost-finding problem in mind, the work will be greatly lessened, and there is no doubt that this feature of factory management will influence, in no small degree, the construction and arrangement of future industrial plants where many and varied products are to be made. The application to complex existing plants is difficult, as before noted, and can be accomplished only by a liberal use of good judgment. Nevertheless, as has been pointed out, even these difficulties are not insuperable in most cases.

Moreover, in comparing the accuracy of the dis-

tribution of expense by this method with that of the averaging methods, it should be noted that some of the production factors of the new method are themselves based on averages. Thus, buildings are not heated and lighted equally all the year round, repairs on all kinds of apparatus are not proportional to elapsed time, and expense material may be bought one day that may not be used for several months. These variable factors of expense must be spread out over more or less arbitrary periods of time, if costs are to be consistent. Again, the expenses that have been incurred during the time a job has been under construction are not always definitely known. If all jobs could be started on the first day of the month and shipped on the last day, it might be possible to allocate with some degree of accuracy the identical expense incurred by each job. Evidently, such conditions seldom, if ever, exist. Work must be started whenever necessary, and shipped and billed as soon as possible, and both production factors and supplementary rates must, in general, be based on previous performances. Usually the record of the previous month is used for rate-setting but some expenses may have to be distributed over longer periods to prevent costs from being erratic. Any claims for great accuracy made by the advocate of any method of distributing expense should be discounted liberally, unless the conditions are so simple that the interpretation of all the factors involved can be clearly seen.

An objection often urged against machine rates, in general, is the penalizing effect on small work which is done on a large machine. It often occurs, especially when work is scarce, that work is done on a machine considerably larger than is actually required for the process. Under the machine-rate method of distributing expense, the job so done receives a much larger share of expense than if done on a tool exactly suited to the operation; thus the job is penalized more heavily, perhaps, than the market price can bear. Furthermore, most records so made are misleading, if not properly interpreted, and if used for future estimates they are likely to make the quotations too high.

While all this is true, the fact remains that the costs obtained by this machine-rate method are closer to the truth than those obtained by averaging methods, which make no distinction in regard to the varying size and cost of the equipment employed. The machine rate is in this respect an index of the efficiency of operation and may serve to call the attention of the manager either to a weakness in his manufacturing equipment or to the pressing need of more work of certain kinds. This may be particularly true in dull times; for in such times the large machines and processes which normally distribute a large part of the expense because of their higher machine rates are usually the first to become idle as business falls off, and the last to resume operations as business revives.

This particular feature of factory work, however, is the cause of one of the most difficult of all cost-finding problems in factories where there is a wide variety in the cost and size of equipment, and where several lines of product are made. This problem will be discussed in some detail in the next chapter.

REVIEW

What do you understand the term "production center" to mean?

If a manufacturing company owns its plant-land, and maintains a power-plant building, an office building, a factory and a warehouse, what would be the production factors and of what would the elements of each factor consist?

What are the defects of and objections to production factors and the supplementary rate?

Could you prepare without reference to the text a set of instructions to a cost clerk explaining in detail the method of operating controlling accounts for expense?

What is the basis for the distribution of each of the production factors?

CHAPTER XV

OTHER FEATURES OF EXPENSE DISTRIBUTION

1. *Variation of expense with volume of work.*—It is a fundamental principle in all the methods of distributing expense that have been discussed, that the *total* manufacturing expense should be kept constantly distributed in the costs as fast as it accrues. The only exception to this principle that has been noted, is in the case of heavy periodic expenses like taxes, heavy repair expenses, or purchases of large quantities of supplies, like coal, for example, where such periodic expenses are distributed over the entire year by means of suspense accounts (see Section 3, Chapter X). If the amount of these periodic expenses that is thus distributed is considered as belonging to the week or month to which it is assigned, the general principle noted in the foregoing treatment holds strictly true for all of the methods discussed.

It appears, therefore, that where this procedure is followed, the cost of production of any given article will vary as the volume of business passing thru the factory changes, since expenses do not vary proportionally with the volume of production (see Section 2, Chapter X). A considerable increase can be made in the volume without necessitating much, if any, addi-

tion to many expense items; while, on the other hand, a considerable decrease may occur in the volume of work without lessening many of the expenses, and, in fact, before it is possible to reduce them to any great extent. Therefore, where all expense is distributed as it accrues, a rise in the volume of product results in a decrease in manufacturing costs; while a decrease in the volume results in an increase in cost. The phenomenon is only too familiar to all who have had experience in factory supervision.

2. *Illogical increase in expense.*—When a factory is running at normal capacity, and care has been exercised to allocate the burden to each article, in proportion to the use that has been made of the facilities of the shop in producing it, the comparative costs of all articles should be fair and logical. If the output is increased, and all costs of production decreased, no line of production can suffer thereby. But should the volume decrease, the case is different. Suppose, for instance, that the volume decreases so that all the large tools are idle and the lines of product on which they are normally used are no longer produced. Under all of the methods of expense distribution that have been discussed, the expense incident to these large tools when idle is distributed against lines of product that make no use of these machines. This is true even in the production-center and supplementary-rate method, the supplementary rate being introduced for the very purpose of collecting expenses

due to idleness and distributing them over the product in process.

Logically, it would seem that any product should bear only the expense incident to its fabrication. Thus, if a manufacturer owned several factories situated in different towns, he would not think of distributing the expense incident to a factory that happened to be idle against the costs of production in the factories that were operating. There would seem to be no reason for doing so, even if the factories were situated in the same yard and were operated under the same superintendent. By similar reasoning, in a factory consisting of several independent continuous processes, it would not appear to be logical to charge the expense incident to an equipment that was idle against those that were operating. In factories of the intermittent type, operating on mixed work involving a large variety of sizes, such clear-cut distinctions as those noted in the foregoing examples are usually not possible, since it is difficult, in such plants, to segregate work and equipment into classes. It will be noted that the production-center method aims to allocate all expenses to each machine and process in such a way as to make it possible to charge every piece of work in proportion to the use it makes of the manufacturing facilities. So far as this allocation is concerned, the production-center method is in accord with logical expense distribution; but the supplementary rate is not logical, in so far as it distributes expenses

belonging to one class of work against the cost of another class. The defense of such a procedure, of course, lies in the assumed necessity of distributing all expense as fast as it accrues. It is held by some accountants and cost experts that this necessity does not exist, and that such complete distribution may often be bad cost accounting, since, when the volume of work is small, this procedure may make the cost of the product that is in process so high as to make selling prohibitive.

3. *Proportional distribution.*—It has, therefore, been advocated by some that the expense distributed against any product should be strictly proportional to the use it has made of the facilities; and that any other expense belonging to any other product should be disposed of in some other way. In judging this suggestion, however, the purposes of cost finding must be kept in mind. If the purpose is to measure the efficiency of production by comparative costs, the method of distributing expense in proportion to service rendered is undoubtedly correct. It does not seem fair to the manufacturing department to charge against it expenses that are caused by idle machines for which it is not responsible. In fairness to the manufacturing superintendent, therefore, these expenses, if included in current costs, should not be confused with the true costs as determined proportionally.

On the other hand, it must be remembered that any expense that is not included in the costs and recovered in the sales price is a loss. Expense cannot be

carried to some account and disposed of, any more than it can be safely forgotten. Entirely aside from any logical principles of expense distribution, expediency would dictate that as much expense as possible be buried in the sales price, regardless of the origin of these expenses. It would be obviously foolish, however, to overburden an active line of production with the expense of inactive lines to such an extent that sales would be impossible; this would seem to be the only danger from a procedure of this kind.

4. *Solution of the problem.*—Two methods of solving this problem have been proposed. The first plan is to carry all expenses due to idleness, directly to the profit and loss account and charge them off as a loss against the business. The error in the reasoning which is back of this plan is that it assumes that all machines should be in operation constantly, and, therefore, that all expense due to idleness is irrecoverable, an assumption that is not necessarily true. A machine may be indispensable and yet be idle a considerable portion of the time, and the expense charge for the machine should be set so as to discharge the total yearly expense over the production for that period. If expenses due to idleness are carried to the profit-and-loss account, the corresponding expense that is discharged when the machine is in operation should also be carried to the same account as a credit, if the usefulness of the machine, and of the line of product produced upon it, is to be judged correctly.

The other plan is to carry all expense to an ex-

pense account and distribute it by one of the averaging methods discussed in Chapter XIII, but to adjust the rate of distribution according to the experience of an entire year, at least, instead of according to the records of the preceding month. The expense account, therefore, will act as a reservoir, discharging more of the expenses in busy periods and fewer of them in dull times. It will, of course, also equalize periodic expenditures, such as taxes, etc. If the rate of discharge is accurately set the entire expense should be discharged at the end of the period for which the rate of discharge is computed. Should there be an undistributed balance in the account at the end of the fiscal year, it can be carried to profit and loss, or it can be carried forward into the next period and the rate can be adjusted so as to distribute it over that period. While this method provides for distributing all the expense without great danger of unduly overburdening production during dull times, it is, of course, open to the same objections that have been urged against all averaging methods (see Section 10, Chapter XIII).

It would appear, however, that an intelligently computed machine rate, like that discussed in Section 13, Chapter XIII, in connection with a supplementary rate based on a long period of time, would do much to solve this perplexing problem. The machine rate would distribute all expenses that are attached to the machine, or process, in proportion to the use that is made of it, irrespective

of the volume of product. The bulk of the costs would, therefore, be proportionally distributed except in periods of great depression when, as has been noted, practically any method is of doubtful accuracy. The supplementary rate, containing the expense due to idle time, would be equalized not only over processes, but also over periods of prosperity and of depression; thus the danger of overburden during dull periods would be obviated. The writer is not aware that this method has been tried; it would seem to be worth investigating.

5. *Other limitations to proportional distribution.*— Mr. H. L. Gantt, discussing this problem in an interesting paper[1] presented before the American Society of Mechanical Engineers, argues that "the indirect expense chargeable to the output of a factory bears the same ratio to the indirect expense necessary to run the factory at normal capacity, as the output in question bears to the normal output of the factory." That is, if the production falls to, say, one-half the normal volume, this production should be burdened with only one-half the normal expense so that, everything else remaining the same, the manufacturing costs would not change with change in volume of product. Granting that proportional distribution is correct in theory, Mr. Gantt's statement is strictly logical only when the decrease in volume of product is brought about by the complete suspension

[1] See *Journal of the American Society of Mechanical Engineers*, August, 1915, p. 466.

of production in some lines, while the remaining lines are continued at normal volume. Mr. Gantt's theory will hold approximately true also for moderate decrease in all lines. But if a great decrease in volume takes place in all lines, which often happens, a rise in productive prices will result from causes which lie in the nature of the expense itself that rightly belongs to every line. As explained in Section 2, Chapter X, expense, in general, does not vary directly with volume of output, but becomes greater in proportion as the volume decreases, since, in practically all expense, there is an irreducible minimum that must be cared for, no matter how small the output may be. There is, therefore, a minimum volume of product that can be manufactured profitably, and beyond which it may be disastrous to continue.

The entire question of variation of expense burden with change in volume of product is interesting, tho complex. It is unwise to make sweeping generalizations regarding a solution; in fact, it is unwise to generalize regarding any problems in cost finding. This phase of cost finding, which has just been discussed, will bear close inspection by managers whose volume of production varies markedly.

6. *Continuous-process costs.*—In continuous processes, or, in other words, where, owing to the conditions of manufacture, the lots of material follow each other in such a manner that the workmen cannot distinguish one lot from another, the production-order method does not apply, and the system of arriving

at cost must be different from that of the outline given, tho the fundamental principles are the same. A consideration of a simple case, such as that of a cement mill, may make the general method clear. Here the material flows in a continuous stream thru the several processes, and the output is more dependent on the machines than on the workmen. The material, moreover, passes thru all of the machines, so that the mill, so far as finding total costs is concerned, may be treated as a single machine. The problem is still further simplified in this case by the fact that the material in process at any one time is not of great value as compared with the monthly output, and therefore can be neglected in computing costs. Furthermore, the material passes thru the mill rapidly, and at no time is there a large amount of labor tied up in material in process. It is evident that all that is necessary, so far as total costs are concerned, is to find the total labor and expense incurred during a given period, and divide this total by the output for the same period; this output may be expressed in terms of weight or bulk; that is, in terms of pounds or barrels. The dividend so obtained will be the amount which must be added to the material cost of each unit of output to cover the labor and expense of production. Obviously, these computations can be made more frequently than in the case of the more complex production-order methods.

7. *Detail-process costs.*—If it be desired to know the cost of each process, or department, of a continu-

ous-process industry, labor and expense costs must be kept by processes or departments, but they may be distributed, as before, by simple division on a material basis, and this will indicate the general method to be pursued in more complex cases. It is usual in such cases to issue a standing-order number to each process, and to charge to this number all labor and expense, if the latter can be segregated. The total amount of these items, for any period, divided by the total weight or volume of all of the manufactured product passed thru the process for the same period, will give the unit cost which must be charged against each unit of material that has passed thru the process. If the expense cannot be allocated to each process, the unit labor cost can be ascertained as indicated in the foregoing treatment, and this cost can be used as a basis for distributing the burden of expense to each unit of product.

Thus, in a factory consisting of several simple continuous processes, each process involving a separate and distinct series of machines, it would be difficult, in general, to segregate accurately all of the expense; hence compromise methods, like those described in Chapter XIV, may have to be employed in such cases for allocating the expense.

8. *More refined process costs.*—The discussion in Sections 6 and 7 of this chapter assumes that the material passes rapidly thru the process, or series of processes, and that, therefore, the labor and expense collected at the end of the week or month, as the case

may be, belong, approximately at least, to the material that has passed thru during that period. If, now, the time required to pass the material thru the process, or series of processes, is considerable, this assumption does not hold true, but part of the labor and expense collected at the end of the accounting period will belong to the material that has passed thru, and the remainder will be chargeable to material in process. The longer the period of fabrication, as compared to the accounting period, the more marked will this condition be. If it is necessary to take this relation into account, as it may be, the cost accounting will involve keeping a record of material that has been issued to the process in question, and of the amount that has issued from it during the accounting period in order that at the end of the period the quantity remaining in process may be determined. The theory of this method [1] is simple, tho the arithmetic may be somewhat confusing in complex cases.

It should be noted, however, that this refinement is necessary only in extreme cases. In process production, as under the production-order method, goods should, in general, be shipped as soon as possible after completion. It is not possible to hold all the goods manufactured during an accounting period till the end of that period, so as to be able to compute accurately the cost of production; therefore, this cost must generally be computed upon the basis of expe-

[1] A brief and clear discussion of this problem will be found in "The Science of Accounts," by H. Bentley, p. 237.

rience in manufacturing similar goods. It will be noted, also, that many expense items can be allocated only approximately; and, where more than one line of goods is in process, accurate allocation is as difficult under the process-production system as under the production-order method. No definite rules can be laid down for these more complex process methods; each problem must be studied independently, individual judgment entering largely into the solution of the problem involved in each set of conditions.

9. *Other difficulties of process-accounting.*—The discussion assumes that the processes considered are continuous, and that all the material of each kind passes thru the same series of machines. If the combination of machines and processes varies from day to day, all the difficulties discussed under the production-order method appear at once. If this takes place, even tho there may be some semblance to continuous production, it is better to pass the material thru in lots, assigning a production order to each lot. Even then, there will be forms of process production that will be troublesome to the cost finder.

In intermittent industries, for instance, there are processes which are continuous in character, and which use considerable expense material the cost of which is difficult to allocate. Processes where material is dipped in insulating fluid—japanning and baking processes, etc.—are instances of this kind. In processes like cement-making it is possible to weigh the material, and to use the weight as a measure of labor

and expense. But in processes like those others just mentioned, such a measure of labor and of expense material is difficult to obtain. Thus, in plating or dipping, the superficial area of the material treated is the proper criterion for measuring expense material, and this area is difficult to obtain. The expense material itself may be measured, but here again more than one kind of product may be treated at the same time, a condition which makes the allocation difficult if not impossible. Similar remarks apply to baking processes where several kinds of products may be baked simultaneously, and where the accurate allocation of direct labor and indirect expense may be impossible. No rules can be laid down for complex cases like these, but a knowledge of correct principles, combined with good judgment, will always indicate compromise methods that will give results, accurate enough, without too much complication.

REVIEW

What is the effect of decreased production upon costs? How would decreased production affect a factory with several independent continuous processes?

How would you deal with the problem of idle time in a factory? Is there more than one method?

What are the salient features of continuous-process cost finding?

Why are continuous-process costs easier to determine than the costs of intermittent processes?

Is any advantage gained by passing material thru continuous processes in lots?

CHAPTER XVI

DISTRIBUTION OF ADMINISTRATIVE EXPENSE—RÉSUMÉ

1. *Distribution of administrative expense.*—Administrative expense and selling expense in most factories, and particularly in small factories, are treated as one item, under the name of general expense, and are usually distributed as a percentage on factory cost. In many such cases it is not possible to make a clear-cut division between these two classes of expense, but whenever possible they should be treated independently, if for no other reason than to fix responsibility. In large enterprises it is usually possible to segregate them, since the sales organization of a large works is usually an independent one; but even here there may be items of general superintendence that should be divided between the two branches of general expense.

It is difficult to distribute administrative expense over factory product in proportion to services rendered, by any method of allocation. Where the factory is very large and divided into departments, each with its own office force, an approach to intelligent allocation can be made, but the average factory is not so arranged. The usual method is, therefore, to distribute the administrative expense as a percentage on factory cost.

Thus, if the factory output for any month is \$50,000 and the administrative expense for that period is \$10,000, the percentage by which the factory cost of each article must be increased in order to absorb the administrative expense will be $\frac{10{,}000}{50{,}000} = 20$ per cent. If, then, the shop cost of a given machine is \$200, its cost, including administrative expense, will be \$200 + \$40 = \$240. The factory cost plus the administrative cost is sometimes called the gross cost.

2. *Selling expense.*—Selling expense is even more difficult to distribute over the product in proportion to services rendered. In the first place, selling has no connection with manufacturing. The factory may be in the country and the sales office may be, and often is, in the city. There is no relation between the two branches, and hence there can be no relation between individual items of selling expense and factory orders. Occasionally, of course, a salesman may do work on securing an order for a particular machine and may be successful. On the other hand, he may fail to secure it, and an order for it may come in unsolicited from some other quarter. Much of the work of the salesman is "missionary," or advertising work, and it is difficult, often, to trace and identify the results of his efforts.

Where the enterprise is very large, and the sales force is divided into departments according to the several lines of product, the cost of selling the several lines may be intelligently allocated against each line.

But here, again, there is seldom any connection between the cost of selling an article in any given line and the cost of producing it, the latter being fixed by conditions that are entirely independent of the cost of selling. The best that can be done, therefore, is to distribute the selling cost as a percentage, just as in the case of the administrative expense.

The computation is simplified, of course, if both administrative and selling expenses are lumped together and so distributed, and this procedure is customary in most plants. It should be noted, however, that there is no reason why the details of such expenses should not be carefully segregated so that the manager can see not only the separated totals of administrative and selling expense, but also the important details of these expenditures. Some suggested details of these expenditures are given in Section 7, Chapter X, but evidently the extent to which such detail may be logically carried will depend on the size and the character of the enterprise. The method of adding the selling expense as a percentage on the manufacturing cost, as discussed in Section 10, Chapter III, should be carefully noted.

3. *Departmentization.*—The advantages of departmentization with reference to cost finding have been referred to several times in the preceding discussion; it may be helpful to note several other aspects of this feature of factory organization. From what has already been said, it will be evident that cost finding is closely connected with factory management; and yet,

in times past, little or no attention has been paid to the problem of cost finding, either in arranging the plant or in organizing its personnel. It will appear, however, that this question should at least be kept in mind in perfecting both plant arrangement and organization.

If a manufacturer were to engage in producing two widely different commodities in two factories, placed side by side, he would naturally organize all "services" for one shop separately, distinct from similar services in the other. He would wish to keep his bills for power, heat and light separate for the two shops and would arrange his transmission machinery accordingly. The bookkeeping systems would be independent of each other and every cost factor would be strictly allocated to the factory to which it belonged. The manufacturer would expect to be able to keep the records of his two activities entirely separate.

On the other hand, a manufacturer might and often does, produce articles of widely different characteristics in the same factory, without any thought of arranging either his plant or his men with a view to separating, as far as possible, the manufacturing costs of the several items. Yet a careful consideration of the cost-finding problem would lead to radically different methods of distributing heat, light, power and similar services and careful departmentization, with the cost problem in mind, would often simplify this same problem.

The foregoing discussion will have made it clear that

the problem of distributing factory expense in any department approaches simple division of such expense as the tools employed become more equal in size and value, as the wages paid approach uniformity, and as the work performed becomes more and more uniform in size and character. The problem of distributing the expense over a department containing twenty-five lathes of the same size and value, operating on exactly the same part, and operated by men of equal wage value and productive capacity, is extremely simple. Such a group can be considered as a large production center and it is comparatively easy to allocate the expenses to it in bulk, and a simple division of this bulk is about all that is necessary, if any at all is necessary. On the other hand, the problem has been shown to become increasingly complex as the component factors named vary increasingly in size, character and value.

4. *Departmentization according to finished product.*—Now there are two distinct methods, or principles, for grouping machines and processes. These affect very greatly not only the physical arrangement of the plant, but also its personal administration, and the ease and accuracy with which expense may be distributed. The first method is to group the machines or processes on the basis of the *character of the finished product*. Thus, in a large machine-tool works organized in this manner, one department would be equipped with a complete set of machines and tools for building lathes; another would be similarly fitted out to build milling machines; and another would have

all the necessary appliances to build drill presses, and so on, each department being equipped entirely independently of the others, and being self-sufficient for the purpose for which it was organized.

This method is a natural outgrowth of conditions in a small shop where the number of tools of any one kind was limited. As new lines of production were added their processes grew up around the personality of some strong executive, or manufacturing superintendent, who often did not want to assume the responsibility of production and delivery unless he had full control of the major part of the productive machinery required. Many executives of strong personality were impatient of the restraint imposed by the necessity of close cooperation between departments. The result of their influence was excessive duplication of tools and processes, and the prevention of the use of more modern forms of administrative organization. This failure to recognize the importance of changing the form of organization as the enterprise grows in size, has doubtless been responsible for the failure of many once prosperous concerns.

5. *Departmentization according to processes.*—Modern organization, however, moves along different lines. It tends to substitute staff organization for individual effort, to replace the versatile individual with coordinated specialization, and to arrange machines by processes rather than by products. Under this second method, therefore, all machines of approximate size and character are grouped together. Thus,

in the example taken above, all turning would be done in one department, all milling in another, all planing in another, and all assembling in another. In each of these departments, in turn, all machines and processes of similar kind and size would be grouped together. Thus all small lathes engaged in manufacture would be in one group, all large lathes in another, and so on. Even in the assembling of the completed product, while all assembly might be in one department, each class of product would be assembled by itself. In other words, by this method, all similar production centers would, as far as possible, be grouped so as to form a large production center, the component parts of which would not vary greatly.

It is evident that this modern method is by far the most economical, and that fewer tools of any given kind will be needed, since the possibility of keeping all machines in operation is much greater when all tools of one kind, and the work which can be done upon them, are collected in one place. The indirect expense for superintendence will be less, and the volume of the product will be greater, since specialization can be made more effective.

Both principles, organization on the basis of products, and that on the basis of processes, should be given careful attention in arranging the plant, especially if cost finding is being considered. In a very large works, for instance, the entire plant may be arranged by products, certain definite buildings being devoted to definite lines of work, so that the total costs

of each line may be easily segregated. The tools and processes used in each line of work may, however, be arranged to best advantage by the other method; that is, according to the processes performed. Careful consideration of the arrangement may make it possible to use a simple cost-finding system, whereas lack of such consideration may make the problem so complex that it cannot be solved even by the most elaborate method. It should, of course, be noted that strict adherence to either form of organization is neither necessary nor indeed always possible. Many departments are equipped primarily to perform a given process, often requiring a few tools of entirely different kinds, simply to save time and transportation. While space does not permit further discussion of this problem, it is one which requires the careful attention of the manager who is interested in costs.

6. ***Résumé of methods of distributing expense.***— The consideration of the several methods of distributing expense and the discussion in Chapters X and XI regarding the character of its several items, will have made it clear that exact allocation of factory burden is not, in general, possible. It is true that in very simple cases, such as are found in the continuous industries, the distribution may be as accurate as is desired, but the general case of intermittent manufacturing does not admit of an exact solution. Even tho clerical machinery be installed which, theoretically, will give accurate results, the expense items themselves are so variable as to make exact distribution

difficult even in simple cases, and impossible where the conditions are complex. This fact is made clear when it is considered that the exact expense to be distributed is itself not always accurately known; distribution must be based on records of the past week, month, or year, as the case may be. In most cases the record of the previous month is used as a basis, but it may be that in some cases it will be better to base the distribution on the average of a number of preceding months. In all cases, however, heavy periodic expense investments should be spread out so as to equalize the costs. The fact that there are so many methods and theories of distributing expense is perhaps due, to some extent, to the fact that there is no absolutely accurate method. The need of some theory on which to build a system of expense distribution is self-evident, but it is equally plain that the theory adopted should be capable of practical application. The method that will be satisfactory in one case may not do at all in another. There are, however, two fundamental principles that should be remembered no matter what system of distribution is being considered.

First, the cost records obtained should state, so far as possible, the facts of the case; they should be records of events that have happened and of nothing else. A clear-cut distinction should be made between costs, as such, and their interpretation and use, which is another matter. Systems of cost based on estimates are in common use. Obviously, such methods cannot be considered seriously, either for accuracy or as a guide

for future action. But, altho the primary object of a cost system is to state facts, due consideration should be given to the use to which these facts are to be put. In general, the two main uses of costs are, first, to show how money has been spent and, second, to indicate how such expenditures may be controlled. In organizing a cost-finding system, therefore, the form in which cost returns are recorded should be carefully considered so that classification and analysis may be rendered easy and simple. A later chapter will treat this matter more fully.

Second, the system adopted should be as simple as it can be, and still be consistent with the problem in hand. The average manager is a very busy person, usually demanding methods that are simple and easily followed and, ordinarily, being suspicious of methods that he cannot understand, or results the derivation of which he cannot easily see. Furthermore, the system should be stable and not subject to constant readjustment because of slight changes in operating conditions, since readjustment usually destroys the possibility of comparison with costs already existing.

For these and many similar reasons the cost system adopted is usually a compromise which takes into account the surrounding conditions. Thus, it would be a useless expense to instal an elaborate machine rate and supplementary rate in a continuous-process industry where a single product is being produced and where a simple method of percentage on material would be accurate enough. Again, in an industry

making a few lines of goods of similar characteristics, where the parts do not vary much in size, and where the machines are all small and inexpensive, a method based upon percentage on wages or upon hourly burden might give results sufficiently close. In more complex cases, as in intermittent manufacturing, where many commodities of varying size and character are made, it has been shown that these simpler methods do not give intelligent results. If the competition is keen the wise manager will go as far as he can in the direction of the machine rate and the supplementary rate. Even in cases of this kind conditions may be such as to permit the use of simpler methods, particularly if careful departmentization can be effected. The general influence of departmentization on costs should not be lost sight of, since by this means all cost-finding methods are strengthened, as has been noted in discussing the several methods of distribution. A later section will discuss this important factor somewhat more fully.

Above all, the manager himself should have a clear-cut view of just what he wishes to do. In general, the practical manager must have the help of an expert organizer to assist him in installing a new system, but he himself should be able to limit intelligently the extent to which the system is carried. It is one thing to lay down general principles, and another to know how far they can be economically carried. One of the most common errors of cost-finding experts who are lacking in practical experience, is to oversystematize

in installing new cost-finding systems, with the result that much useless information is gathered and eventually much of the elaborate system is discarded. The cost-finding expert should be a master of the principles of his business; the practical manager should supply the limitations of the system. And finally, it is of supreme importance that *some* system, be it ever so simple, should be in service. A factory without a cost-finding system is like a ship without a rudder, and in these days of strenuous competition it is sure to go on the rocks of failure.

REVIEW

How would you distribute administrative expense?

Upon what basis is it advisable to distribute selling expense?

If part of the selling expense is incurred in securing orders for the next season's delivery, would you consider it proper to carry forward such portion as an asset to be charged against the next season's sales?

What do you understand by departmentization: (a) according to finished product? (b) according to processes? Which of these methods is more in accordance with modern ideas of organization?

What are the fundamental principles to be taken into consideration in the planning of any system of expense distribution? What are the difficulties to be anticipated?

CHAPTER XVII

ASSEMBLING AND RECORDING COSTS

1. *Uses of costs.*—It will be evident that the manner in which costs are recorded and the detail with which the recording is carried out will vary greatly with the enterprise, and with the point of view of the manager. In some simple continuous processes lump sums only may be required, while in intermittent production involving many kinds and many sizes of parts, the detail in which costs are collected and recorded may be very great. The detail of cost accounting will also vary greatly with the purposes for which it is desired to use the collected cost data. These purposes may be several, but in general they may be summed up under these heads:

(a) To show the actual cost of operations or performances.

(b) To form the basis of managerial and other reports.

(c) To serve as a basis of predicting future performances.

The first purpose constitutes, of course, the fundamental reason for keeping costs. In so far as total profits are concerned, there is no necessity, as will be shown, for a cost-keeping system. But it is essential

in most industrial enterprises to know, as closely as possible, the cost of producing each individual article, sometimes even of each part, if for no other reason than to know which lines are paying and which are not. It should be fully realized that factory costs are not always serviceable in fixing selling prices. In many instances the selling price must be fixed by the prevailing market price, and this may have little relation to the cost of manufacture. Such circumstances are especially likely to prevail in lines of work where cost-finding methods are, in general, crude and poorly understood. Yet this is all the greater reason why, in such cases, costs should be known as accurately as possible. A knowledge of the details of the cost of producing any article is a good start toward reducing the cost. A knowledge of the actual facts concerning the cost of production of each article, as far as it is economical to obtain them, would seem to be a common-sense requirement for a continuation of any enterprise. There is no doubt that it is a lack of this fundamental knowledge which carries many enterprises "to the wall." The detail methods of recording cost data will be discussed in this chapter.

2. *Cost data for predicting performance.*—As already noted in Section 3, Chapter III, a cost-finding system that is used only for recording costs has fulfilled only a part of its true purpose. Too many managers think of costs simply as records of performance, whose usefulness is ended once the goods are billed. Now the most significant movement in modern manu-

facturing is the tendency to predict all manufacturing performances. The engineering and designing departments long ago began the prediction of the constructive features of manufactured products. The form and dimensions of all manner of articles and even of the tools for producing them are predicted, as well as the practical and theoretical performance of the completed product. Careful managers have for many years endeavored to foretell the times and costs of productive operations with the same degree of certainty that has been attained by the engineer and the designer. One of the cardinal principles of so-called "scientific management" is the securing of advance knowledge of the time and cost of each operation in detail, without leaving anything to chance or judgment. And just as collected scientific knowledge forms the background of engineering production, so collected cost data, including the two important factors of time and wages, form the basis of all predictions of productive performance. The relation of time study and motion study to cost prediction is the same as the relation of engineering research to engineering design. Any system of recording costs, to be most effective, must be arranged with this feature of management in view. A more extended discussion of this important phase of cost finding is given in Chapter XIX.

3. *Value of expenditure reports.*—In addition to the two functions of cost records discussed above, reports should also show the distribution of expendi-

tures. The total expenditures, while showing the manager the probability of gain or loss, do not tell him much regarding the ways in which money has been spent, or indicate to him where he must insist upon retrenchment and improvement. He cannot find this information by a personal inspection of the details of the cost records, except as those records apply to specific parts. If, however, the cost data are carefully classified and gathered up into reports, a very clear idea of the most important tendencies in the business can be secured by the manager. Classification and summarizing of cost data according to the character of the expenditures is hence an important feature of cost recording, and it must be kept in mind in the organization of the clerical machinery of the department. This feature of management will be more fully discussed in Chapter XVIII.

4. *Sources of cost data.*—The detail necessary in recording costs of production will vary with the relative amount of consideration given to the three general uses of cost data which have just been discussed, and also with the amount of detail involved in the job concerned and the character of the processes used in doing the work. Obviously, no one system is applicable to all cases, but there are a few general principles in common use which may be helpful. Referring to the last item, the character of the processes used, one can clearly see that the methods used in summarizing costs for a continuous-process factory, or for one using processes in such a manner that it is difficult to tell

where one job stops and another begins, will be somewhat different from the production-order method, by which each job is kept distinct from all others. The discussion will, for the present, be confined to the production-order method; the process method will be considered later.

It will be remembered that in the production-order method all time expended is recorded originally on some form of work card (Figures 14, 15 and 16, pages 130, 132), which identifies the work performed with the shop-order number, the part or drawing number, the time expended, and the workman who does the work. All material used will be reported from the storeroom by means of the requisition on which the material has been issued. Sundry expenditures which are neither labor nor material but which are chargeable against specific jobs, will appear on properly approved vouchers. The indirect charges will be reported just as direct labor and material are reported, so as to be charged against the proper standing-expense order numbers, to allow of their total amount for any given period being ascertained.

5. *Cost ledgers.*—Now if the work is of such a character that each shop order involves only a few charges for material and labor, it is obvious that such charges, with the correct expense charge belonging with them, could be carried directly to the general-ledger account of the order concerned, and with any other charges properly relating thereto the entire transaction could be recorded in one small ledger account. On the other

hand, if the job involves many operations and its construction is to extend over a considerable period of time, such procedure would make the general ledger too bulky and would tend to obscure its true object as a summary of the business. For this reason costs of a complex character are usually collected by some form of cost ledger, the function of which is to record permanently the details of items entering into the cost of production. Summaries only of the cost ledger without details are carried to the corresponding accounts in the general ledger.

Cost ledgers, like all other subsidiary ledgers, such as the stores ledgers and stock ledgers, are most conveniently made up in the form of a card system. The forms of ruling for such cards must, of course, be suited to the requirements of the business. If the number of entries for each job is not too great, a single card may suffice to carry the record of all the details of its production. A cost-finding sheet of this character is shown in Figure 21 (page 274). It will be noted that provision is made for recording the cost in considerable detail under the three principal factors, material, labor and expense. The several operations performed upon the piece are noted, with the workman's number and his rate. The total cost also is usually noted upon the card by adding the general expense to the total factory cost as recorded.

It may be more instructive, however, to describe a typical method of recording costs where the details are beyond the capacity of a single card. It will be

understood that the procedure described is a typical one only, and simply suggestive of the general methods in common use. The discussion will be confined for the present to the problem of finding total costs which was stated as the first of the uses for which costs are kept.

6. *Labor and material cards.*—When a production order is placed in the shop an account is opened in the cost ledger by placing in its files the necessary cards properly filled out. These will consist generally of a labor-cost card and a material-summary card. The work cards (Figure 14, 15 and 16, pages 130, 132), are collected daily and, after being approved by the proper foreman, are forwarded to the cost department. Here they are first sorted according to workmen's numbers, that is, all the cards sent in by any one workman are grouped together. It will be noted that, in best practice, each workman will send in, daily, a separate work card recording the time he has worked on each and every job, whether he has finished the job or not. The difficulty of separating different labor items placed upon the same work card will be apparent. The wages represented by each card are now computed and noted thereon. This may be based upon day-pay, piecework or premium-plan methods, but in every case the wage so recorded is the labor cost chargeable against the job, so far as that particular work card is concerned. If the expense is distributed by machine rate, or if different percentage rates are used for different departments of the fac-

tory, the expense belonging to each work card should also be computed at this time and noted upon the card. If a fixed percentage is used for all work alike, it is generally more convenient to defer the computation of the burden until later.

The total time recorded by each man can then be checked against the time-clock or the checkboard record to insure that all elapsed time recorded by these records is accounted for. The daily payroll may now be made out. If all men are on day pay an independent payroll may be made out, based upon the clock or the checkboard record; this must check against the costs as shown by the work cards. If, however, piece rates or a bonus system be in use, the payroll should be based upon the work cards, tho, even then, the elapsed time must check against the clock record.

7. *Labor-cost sheet.*—The work cards are then sorted by production orders, that is, all cards bearing the same production-order number are brought together. The items referring to each production order are then posted on a labor-cost sheet, as shown in Figure 22 (page 276), a separate sheet being made out for each production order so that the total labor cost of the order concerned can be summarized at any time. In cases where the labor charges are few, they could, of course, be posted directly to a cost-summary card, such as is illustrated in Figure 21 (page 274). The detail in which the labor cost may be recorded on the labor-cost card must, of course, vary with conditions. It may be a simple running memorandum, a sum-

COST SHEET

NAME OF ARTICLE..............................
DATE FINISHED..............................
NUMBER MADE..............................
UNIT FACTORY COST..............................

SHEET NO...............
CATAL. NO...............
DRAW. NO...............
PROD.-ORDER NO...............

DATE	MATERIAL					LABOR					INDIRECT	
	DESCRIPTION	REQ. NO.	QUANTITY	RATE	AMOUNT	OPERATION	CHECK NO.	HOURS	RATE	AMOUNT	%	AMOUNT
TOTALS												

FIGURE 21

mary of which will give only the total labor cost of all operations, or it may be arranged so as to give the total labor cost by operations, as illustrated in Figure 20 (page 233), where similar operations may be totaled. Either the amount of each work card may be recorded, or the cards may be recorded in groups, as conditions dictate. In so far as securing total labor costs is concerned, the work cards are no longer necessary after they are posted on the labor sheet. Their further use in securing statistical costs will be discussed later.

8. *Material-cost sheet.*—The material requisitions, after being properly evaluated either by the storekeeper or in the cost department may, if their number is small, be filed with the labor-cost sheet. If, however, there are many material entries they may be posted on a material-cost sheet in the same way that labor charges are carried on the labor-cost sheet. For the ascertainment of total charges the material requisitions have then fulfilled their service, but like the work cards they are still useful for statistical purposes.

The costs of indirect labor and material are gathered in the same manner as in the case of the direct costs—the detail costs, as they come in on work cards, and the material requisitions being carried to the proper expense account. The total of these expense accounts must be compared periodically with those of preceding periods, to insure that the factors used in their distribution are accurate.

9. *Cost-summary sheet.*—From the labor-cost sheet and the material-cost sheet the total prime cost to

LABOR-COST SHEET

NAME OF ARTICLE ____________ SHEET NO. ____________

NUMBER MADE ____________ PROD. ORDER NO. ____________

DATE	CHECK NO.	HOURS	RATE	LABOR COST									TOTAL
				ASSEMBLE	BORE	DISMANTLE	DRILL	GRIND	HARDEN	MILL	PAINT	TURN	
TOTALS													

FIGURE 22

date may be summarized at any time. When the job in question is finished, the summaries of both of these sheets are carried to a cost-summary sheet. If only one article is involved and all labor and material items are carried to a cost-ledger card, as shown in Figure 21 (page 274), the summary may be made directly upon it. To the prime cost, so summarized, is added the expense, if it is distributed by a percentage method; or the proper proportion of the supplementary expense is added if the machine-rate method of distribution is in use. If there are any sundry charges that are chargeable directly to the production order, as shop expense, these are also added; in this way the factory cost is completed. To the factory cost is added the proper percentage for general expense and selling expense, and thus the total cost of the article is obtained.

10. *Grand cost summary.*—If any particular job consists of many parts, and production orders have been issued for each part, so as to segregate its cost, a grand summary of all cost-summary sheets for the entire job must be made, as shown in Figure 23 (page 278), which illustrates clearly the summarizing of the costs for a direct-acting steam pump. The figures given are hypothetical and taken somewhat at random. The need of such methods will be made more apparent by a consideration, for example, of the costs of a large multiple-cylinder marine engine, where it is desired to obtain the individual costs of the several parts, or group of parts, which make up the engine.

COST-SUMMARY SHEET

NAME 16×9×12 Dup Pump SHEET NO. 642

NUMBER MADE 1 PRODUCTION NO. 2346

NUMBER	NAME OF PART	MATERIAL		LABOR		PRIME COST		EXPENSE		COST	
2	Steam cylinders	35	45	50	20	85	65	40	16	125	81
2	Water cylinders	50	20	60	10	110	30	48	08	158	38
1	Frame	15	60	20	05	35	65	6	04	41	69
1	Steam piston	5	06	15	16	20	22	12	12	32	34
1	Water piston	7	08	14	64	21	72	11	71	33	43
1	Piston-rod	3	04	2	60	5	64	2	08	7	72
1 set	Valve gear	7	24	24	06	31	30	19	24	50	54
1	Air chamber	6	80	2	46	9	26	1	96	11	22
	Assembling and testing			64	20	64	20	51	36	115	56
	Miscellaneous			6	24	6	24	4	99	11	23
	Factory cost									587	92
	General expense 15%									88	18
	Selling expense 5%									29	39
	Total Cost									705	49

FIGURE 23

Or, again, if it is desired to obtain not only such individual costs but also the summarized costs of the propelling machinery, such summaries are a necessity. In the example shown, Figure 23, the factory expense is computed separately, as would be necessary if different percentages were used in different departments. The general and selling expense is also computed and added, and in this way the total factory cost is obtained.

11. *Comparative records.*—It will be evident that the above methods are sufficient for the purpose of recording total costs. If, however, it is desired to use these recorded costs as a means of fixing piece rates, or estimating on contracts, it is very often desirable to express them comparatively, since a single set of costs is not likely to be reliable as a guide to future work. If costs are recorded by production-order numbers, as explained in the foregoing discussion, only the totals of the several items are quickly available.

In the case of the pump, illustrated in Figure 23, the summary will have back of it a number of subsidiary summaries, each giving the total for one of the components of Figure 23. If these subsidiary summaries are filed under the controlling production-order number, it is obvious that more or less difficulty will be experienced in finding the comparative cost of a given piece as manufactured for different pumps of the same size and kind.

12. *Costs by classes.*—If, on the other hand, the cost of detail parts is recorded by classes and not by

COMPARATIVE-COST SHEET

MATERIAL T.S.
WEIGHT 10#
PRICE 05
NO. ON EACH MACHINE 1

ARTICLE Turret Lock Ring

SHEET NO. 2368
DRAW NO. 4679 A
CAT. NO. 02468
DATE 4-11-16

LOT NO.	PROD-ORDER NO.	NO. MADE	NO. OF MIN. FOR EACH OPERATION AND COST PER PIECE IN CENTS																																	MATERIAL	EXPENSE	TOTAL COST PER PIECE
			PLANING			TURNING			DRILLING			MILLING			BORING			SHAPER WORK			GRINDING			SCRAPING			VISE WORK			TOTAL TIME AND COST PER PIECE								
																														M		A		H				
			M	A	H	M	A	H	M	A	H	M	A	H	M	A	H	M	A	H	M	A	H	M	A	H	M	A	H	HRS.	MIN.	HRS.	MIN.	HRS.	MIN.			
						54					39		79				70				70	18								2	4	4	25	1	47		100%	
11	386	20				24					13		8				22				37	23									61		31		35	.50	1.27	3.04
						107					32		25				63				63	68								2	50	1	33	1	35			
12	418	22				54					10		6				21				34	7									88		13		31	.50	1.32	3.14
							62				31		49				50				62									1	2	1	51	1	21			
13	438	25					8				10		5				18				33										33		13		28	.50	.74	1.98
						38					41		53				44				79									1	57		53	1	25			
14	450	25				18					12		7				16				23										41		7		28	.50	.76	2.02

FIGURE 24

production-order numbers this difficulty is obviated. This method is illustrated in Figure 24, opposite, where the details of the manufacture of several lots of turret-lock rings for turret-lathes are thus recorded. The record given in Figure 24 is very complete, the work being recorded by classes and also by production orders. The M, A and H, under each class of operation, indicate whether the work has been done by a mechanic, apprentice or helper. The number of minutes expended on each operation for the lot is recorded and directly underneath is the cost per piece. On the right the totals of these items are summarized, together with the total cost per piece in each lot. Records of this kind are very instructive in setting piece rates or comparing methods of production.

13. *Detail of costs.*—In the case of the construction of a single machine or of a small number of machines, where a repetition of the order is not probable, it is sufficient to record the cost by production-order number, filing the detail and summarized costs, which are obtained, under a few order numbers. But in manufacturing a standard product, which is in more or less continuous production, the method of filing by classes [1] is much more useful. Obviously, many variations may be made in these methods, and it should be remembered that the usefulness of the final cost record depends largely upon the intelligence with which the production orders are issued. In one case

[1] In the *American Machinist* of May 16, 1912, on page 703, will be found a description of a cost-recording system, arranged by classes, as used by a manufacturer of both standard and special pumps.

it may be sufficient to group all costs under a single order number and summary; in another it may be necessary to divide the job under a number of production orders, and to carry the summarized cost of each group to a grand summary under the main order number; or, again, it may be necessary to record all costs by classes and make up the total cost of a given product from class costs. In still more complex cases the main parts of a machine may be made on a special production order, while, to complete it, many auxiliary parts may be used that have been manufactured on class-order numbers. In the last method, the drawing list, Figure 5 (page 55), is an essential feature of the productive process.

14. *Indexing cost summaries.*—It is clear that in a busy factory turning out many jobs monthly the cost-summary cards will increase rapidly. They should therefore be filed in some systematic manner, and if necessary should be indexed in some way so as to make reference to them quick and accurate. In many cases an alphabetical index by customers' names may be sufficient; but in most cases filing and indexing by classes is necessary. Thus all generator costs may be filed together, all induction-motor costs may be filed together, and so on. In the system referred to in the footnote on page 281, the method of filing and indexing by classes is very fully worked out. Thus, in that system, all cylinder-head costs are filed together, all connecting-rod costs are filed together, and so on. Clearly

a good index makes the cost records very much more effective; in fact, in large systems it is indispensable.

15. *Relation between general accounts and cost accounts.*—From the foregoing discussion the relation between the general books and the cost accounts will be clear. The general accounts, as a rule, concern the operations of an enterprise as a whole. The entries in these books cover the exchange of values between the organization and other organizations or individuals. They do not take cognizance, in detail, of inventories, changes in plant valuation, or manufacturing expenses. The cost accounts, on the other hand, are concerned with the movements of values, in detail, within the organization. They are particularly concerned with inventories, depreciation, the distribution of manufacturing expense, and similar items.

Cost accounts should be regarded as detailed statements, or amplifications, of the condensed statements shown in the general accounts. They should give in detail the causes which produce the totals, and should enable the manager to reason intelligently regarding these totals.

It should be carefully noted that, so far as finding the total profit or loss of any enterprise is concerned, cost accounts are not generally necessary. Thus, referring to Figure 3 (page 27), it can be seen that all the items necessary to show profit or loss can be found from the general accounts, except the items of inventory. As before noted, these inventory values may

be found by visual appraisal. In many enterprises this practice still prevails, tho, as has been stated, it is to be recommended only as a check on the more advanced inventory methods that have been discussed.

It is customary in most enterprises to show the results of the manufacturing and trading parts of the business, by what are called "manufacturing" and "trading" accounts. On the debit side of the manufacturing account is placed the inventory value of the material in stores and in process at the beginning of the period under consideration, while the value of the same items at the end of the period is placed on the credit side. The difference is the gain or loss in these values. The value of the purchases and the wages paid during this period, with all legitimate manufacturing expenses, are also placed on the debit side. The balance of the account, representing cost of manufacture, is charged to the trading account, on the credit side of which are placed the receipts from sales. The selling and administrative expenses are also charged to the trading account. The difference between the two sides of the account shows whether a gain or a loss has resulted during the period under discussion.[1]

To ascertain the total profits, therefore, it is not necessary to know the manufacturing cost of individual pieces of product; only the total cost and total sales are needed, provided an inventory is compiled

[1] See discussion of this subject in the Modern Business Text on "Accounting Principles."

at the beginning or the end of each period for which a financial statement is made. There are many concerns in this country that still operate on this plan of selling at market prices, regardless of manufacturing cost; they rely on a periodic inventory to find out whether a loss or gain has occurred. Such an inventory cannot be conveniently made, in most cases, more frequently than semi-annually, and the danger of such a method is self-evident. On the other hand, many accountants and auditors have little faith in cost-accounting methods; they prefer to deal with values which are definite, as is the case with direct expenditures for material and wages, and inventory values based on visual examination of the assets. They prefer this method of ascertaining the total cost of the manufactured product.

16. *Cost accounts should agree with general accounts.*—A cost system may, therefore, be operated with little relation to the general accounts. It might, indeed, be useful to the shop manager as a guide in operating the factory, and might serve also to fix selling prices, without being closely connected with the general books. It should not be forgotten, however, that if the cost system is at all accurate, the sum of the detail values which it shows will agree closely with the corresponding totals as found in the general accounts. It should be noted, also, that the general accounts are the only means available for checking the accuracy of the cost accounts. For this reason the cost accounts should be closely connected with, and

merged into, the general accounts. In very simple cases, the general books may include all the detailed costs that are collected.

In a manufacturing business, for instance, the following accounts might appear among the general accounts:

Machinery and equipment
Reserve for depreciation
Patterns and drawings
Small tools
Raw materials
Manufactured parts
Factory supplies
Manufacturing expenses
Goods in process
Finished products.

Clearly, these accounts must be fed from the cost accounts and it is possible to create such general accounts as will serve to collect the totals of the cost accounts. If the cost accounting be correct, the totals thus obtained will check closely with the totals that are found directly from the payroll, the cost of purchases, and other accurate sources of value. Thus, the sum of the wages which are charged in the cost accounts against productive orders, and which appear in detail in the several job accounts, should agree with the total direct payroll as reported by the paymaster. The total manufacturing expense charged in detail thru the cost accounts should agree closely with the totals of such expenses as shown by the purchases and

the indirect payroll. The material charges, however, cannot be made to check so exactly, since the element of waste, and similar losses, cannot be accurately evaluated; but even these totals should not differ greatly. If they do the error should be found. In general, of course, the error is more likely to be found in the cost accounts than in the general accounts.

The degree to which the general accounts and the cost accounts may thus interlock will, necessarily, vary with conditions and with the opinions of those concerned. It seems that, in this country at least, the tendency is toward a closer relationship between the two sets of accounts. This is logical, since, as has been explained, the cost accounts are really an amplification of the general statements and should be accurate enough to check, at least fairly well, with the more accurate general accounts.

REVIEW

How would you rule a form of cost-summary sheet? A labor-cost sheet? A comparative cost sheet?

What are the sources of cost data and the general methods of securing them?

Could you outline in the form of instructions, the several steps in assembling cost data?

How would you index cost summaries so as to provide for quick and accurate reference?

Do you clearly understand the relation that the different forms mentioned in the text bear to one another?

Discuss the relation which should exist between the cost accounts and the general accounts.

CHAPTER XVIII

STATISTICAL RECORDS AND REPORTS

1. *Reports in general.*—It was noted in the preceding chapters that the three principal uses of a cost system are to show the actual cost of operations, to form the basis of managerial reports, and to assist in predicting future performances. The first item has just been discussed; the second will form the basis of this chapter.

In an industrial enterprise of any considerable magnitude it is impossible for the manager to keep under his immediate and personal control much more than the general direction of the business. He must delegate responsibility and authority to those directly under him, and these in turn must still further intrust responsibility and authority to those under their direction, and so on down the entire line of organization.

As the enterprise grows the duties of the higher officials come to be more and more of a supervisory nature, and details must more and more be trusted to subordinates. But as the business grows it also becomes more difficult for those in authority to see, by personal observation alone, exactly what is taking place under them; while, at the same time, it becomes increasingly important and necessary that they have

a clear conception of these matters if they are to guide the enterprise successfully. Some one has said that the secret of success in management is to organize, deputize and supervise the activities of the enterprise; and in a rough way this expresses the general principles concerned. If the management cannot personally perceive what is happening under him, he must at least organize his methods in such a way that all tendencies and indicative results will be brought before him in a clear light.

2. *Financial statements.*—Since commercial success is measured in money, it is natural for the manager to look for such financial statements as will throw light on his problems, and he naturally turns to his general accounting books for any help that they may give. In so far as general results are concerned, these are helpful, and the balance sheet and profit-and-loss account, containing, as they do, a summary of what has occurred, are very helpful in problems of management. But these statements are given to him only at long intervals, while his daily problems of management demand up-to-date information regarding many details of the business that do not appear separately in the general statements, but which may be found in the cost system in one form or another. From what has been already said it will be evident that a manager cannot find this information himself; but if he knows the content and form of what is desired, the cost system can be so arranged as to supply it automatically and periodically.

3. *Value of reports.*—This broader conception of cost finding as a means of measuring and controlling industrial activities is not very generally appreciated. A system of carefully selected reports is the only method by which a manager can form an intelligent estimate of the controllable and the uncontrollable factors of his business; it is also the best way by which to find the need of betterments and to direct their enforcement intelligently. The number and character of the reports which a manager may consider necessary will differ with the industry. Moreover, they may not all be based upon the cost system. It is evident, however, that a cost-finding system is necessary for most of the important managerial reports of a manufacturing enterprise. The profit-and-loss statement can usually be made up at the end of the year, or at other times when an inventory is taken, with no reference to a cost system; but if it is desired to make such a monthly statement as is illustrated in Figure 3 (page 27), it is obvious that some regular method must be employed to evaluate the cost of such items as material, work in process and finished product.

4. *Departmental and other reports.*—Aside, then, from the question of financial reports that grow naturally out of the general accounting, it may be good policy to call for special reports from departments, or such other activities as will best serve to indicate the trend of the business. The sales department, for instance, should make a periodic report showing the amount and character of sales, and similar

information. It should also send in special reports, bearing on any movement in the field, that will be useful in manufacturing. From the stores department the manager should receive a report of product on hand; from this and a manufacturing report of the orders in process he can intelligently place new shop orders. Other departmental reports of a similar character make the solution to the various problems of management more sure and accurate. The periodicity of these departmental reports may vary, but in most cases they are rendered monthly. Some accountants prefer to make such reports every four weeks; thus there will be a total of thirteen equal periods a year.

Of the reports depending on the cost system none is more important than the so-called monthly statement (Figure 3), which is a concise statement of the condition of the business at the time considered. The sources of some of the items are, of course, found in the general books, but unless a good cost-finding system is in use the items of material, work in progress and finished product cannot be evaluated on short notice. The methods of evaluating these items have been fully explained in previous chapters and will not be further discussed, except to note that these values are always available from the several ledgers of the cost system and the ledger accounts of the general books.

5. *Labor reports.*—Reports such as those just mentioned can be abstracted from the general books and

the subsidiary ledgers without special effort, but there are other reports that are exceedingly useful which, in most cases, must be specially compiled. One of the most important of these is the labor report, which is usually compiled weekly. Referring to Section 6, Chapter XVII, it will be seen that the work cards were sorted, first by workmen's numbers so as to make up, or to check, the payroll, and resorted afterward by production numbers so as to distribute the wages against production orders. If they are now sorted by classes of labor, a report such as illustrated in Figure 25 results. This last sorting process can be greatly facilitated by giving distinctive colors to the several classes of work cards so that they can be sorted readily. This is especially true since, in this case, total results only are desired. The labor report is a classified statement of all expenditures for labor; it enables the manager to see at a glance where money that has been paid out in salaries has gone, and to keep a check upon all such expenditures. Such a report is made more valuable if compiled in a comparative manner. Thus, if the record of preceding weeks is shown as indicated in Figure 25, or if the average of former records, or the records of corresponding periods of the preceding year are given, the general tendency is made much clearer.

6. *Interpreting labor reports.*—Care should be taken, however, in drawing conclusions concerning different classes of labor on the same report and at the same period. Thus, the ratio of indirect labor to di-

BROWN MFG. CO.

LABOR REPORT WEEK ENDING________

ACC'T. NO.	CLASS OF LABOR	WEEK ENDING		WEEK ENDING		WEEK ENDING		SAME PERIOD LAST YEAR	
	DIRECT LABOR								
A	A. C. GENERATORS								
B	INDUCTION MOTORS								
L	DIRECT-CURRENT GENERATORS								
M	TRANSFORMERS								
RA	ARC LAMPS								
UA	SMALL MOTORS								
S	LIGHTNING ARRESTERS								
O	MISCELLANEOUS								
	UNIT COST DEP'TS								
	IRON FOUNDRY								
	BRASS FOUNDRY								
	TOTAL DIRECT LABOR								
	MANUFACTURING EXPENSE								
200	FACTORY SUPERVISION								
201	STENOGRAPHERS								
202	PRODUCTION CLERKS								
203	COST CLERKS								
204	STORES CLERKS								
205	SHIPPING CLERKS								
206	OTHER CLERKS								
207	OFFICE BOYS								
212	FOREMEN AND ASSISTANTS								
213	INSPECTORS								
214	ELEVATOR AND CRANE MEN								
215	WATCHMEN								
216	GATEMEN								
217	CLEANERS AND OILERS								
218	HELPERS AND LABORERS								
219	SHIPPING CLERKS AND HELPERS								
220	OUTSIDE-CONSTRUCTION MEN								
221	PACKING								
222	YARD TRANSPORTATION								
223	STABLE AND GARAGE SERVICE								
224	FACTORY ERRORS								
225	FIRE DEPARTMENT								
226	ALL OTHER SERVICE								
	TOTAL MFG. EXPENSE LABOR								
	POWER HEAT AND LIGHT								
	MAINTENANCE OF PROPERTY								
301	BUILDINGS								
302	PIPING AND WIRING								
303	MACHINERY AND TOOLS								
304	PATTERNS								
305	MISCELLANEOUS								
	TOTAL MAINTENANCE OF PROPERTY								
	TOTAL INDIRECT LABOR								
	PLANT INVESTMENT								
	OPEN ACCOUNTS								
	ENGINEERING								
	EXPERIMENTAL								
	TOTAL OPEN ACCOUNTS								
	TOTAL PAYROLL								

FIGURE 25

rect labor is often taken as a criterion of efficiency of production. While indirect labor must always be carefully watched, and while the ratio is often an important indication of tendencies, it is not always a criterion of increasing or decreasing efficiency. Suppose, for instance, that certain operations are being performed on cheap standard tools by high-priced men in such a manner that the direct-labor cost is large but can be accurately allocated to production orders. Suppose, now, that because of increased quantity it has become possible to transfer this work to high-priced automatic machines, located in the automatic-machine department where, because of the nature of the work, all labor is indirect. The direct labor formerly charged against this class of product is now replaced entirely by an indirect labor charge, and perhaps a heavier machine-rate charge is imposed because of the more valuable equipment. Yet the cost of the product may be very greatly reduced because of this change in manufacturing method, tho the ratio of direct to indirect labor would give no indication of the fact.

7. *Lost time.*—It was shown in Section 3, Chapter XI, that lost time, either of men or of machines, is not a just charge against specific-job costs. It was also shown in Chapter XIV that by the production-center method of cost finding, lost time is accounted for and can be used as a measure of the activity of the enterprise. Even where such advanced methods of accounting are not in operation, it is an excellent plan

to have all idle time reported regularly and systematically. A good workman who is absent a large portion of the time may not be as valuable as a mediocre man who is faithful to his work. A machine that is idle a large part of the time, either from lack of work or because it is constantly breaking down, should be the object of a careful investigation.

8. *Material reports.*—The purchase-analysis sheet, Figure 7 (page 72), gives the manager a clear exposition of all materials purchased, as well as the general disposition of this material. This may or may not be sufficient for his purpose; it may be necessary to see that this disposition is correct and is faithfully carried out. Other reports may therefore be needed.

Material may be wasted as a result of several causes as, for instance, faulty design; changes in design, which leave on hand special material that cannot be used; and the spoiling of material by poor workmanship or bad storage. There is also an unavoidable loss due to fabrication in the form of cuttings, scraps from punching, remnants, etc., which may represent more value than the manager realizes.

These sources of loss will serve to indicate the character of special-material reports that may be valuable. Thus, periodic reports of all special material on hand, both active and inactive, may save large sums of money, especially if the material is of great value, as in the case of copper supplies. It may be desirable to have all material going into each line of product classified and reported, by the same method as that

used in the case of labor (see Figure 25, page 293), with a view to checking the losses due to fabrication.

Material losses due to poor workmanship or defective material should always be reported fully. This report should give not only the order number of the part that has been spoiled but also the name and number of the man responsible. In some cases where a number of duplicate parts are put thru the factory in a lot, a continuous report is kept of the progress of the lot from process to process; the report is consequently a history of the losses thruout fabrication. This procedure may be of great importance where the work is of a refined character and is inspected after each operation; it is especially important in cases where the workmen are paid by the piece.

Obviously, the particular kind of material reports required for any industry will depend on conditions, and the form of the report blanks will also depend on circumstances. No effort, therefore, is made to illustrate any blank forms of this kind. The object has been to call special attention to a phase of industrial management that is often overlooked and neglected. As has been shown, it is always difficult to make the material-cost summaries agree with the material summaries of the general books. No doubt, the lack of agreement can be much lessened by more careful investigation of what disposition is actually made of all material purchased.

9. *Expense reports.*—Another very important class of reports founded on the cost system comprises the

analysis of expense. These may be in any detail desirable, from a general summary of expenses, to detailed departmental reports. Figure 26, below,

EXPENSE-ANALYSIS SHEET
POWER, HEAT AND LIGHT

FORM____________
DATE____________

ACC'T NO.	CHARACTER OF EXPENSE	FOR MONTH OF____________		FOR PERIOD TO DATE	
	LABOR				
	ENGINEERS				
	FIREMEN				
	HELPERS				
	REPAIR LABOR				
	SUPPLIES				
	COAL				
	SHOVELS				
	BARROWS				
	OIL				
	MISCELLANEOUS				
	REPAIR MATERIAL				
	BOILER REPAIRS				
	ENGINE REPAIRS				
	GASKETS AND PACKING				
	MISCELLANEOUS				
	DEPRECIATION, INSURANCE, ETC.				
	TOTAL				
DEP'T	DISTRIBUTION BY DEPARTMENTS				
A	PER CENT OF TOTAL 6				
B	" " " " 12				
C	" " " " 11				
D	" " " " 27				
E	" " " " 25				
F	" " " " 19				
	TOTALS 100				

FIGURE 26

illustrates an analysis of a heat, light and power account, showing the cost, by items, monthly, and also the totals to date, as well as a digest of the distribu-

tion of the total by departments. Reports of this kind are of great variety, and are exceedingly useful to the manager.

In its best form the expense report will place before the manager a condensed statement of such expense items as are unavoidable. By reference to Figure 17, page 148, it may be seen that these items are many, and that the amount of detail allowable in the report should be a matter of careful consideration. In large enterprises, a condensed expense report should have back of it departmental reports, such as are illustrated in Figure 26. Obviously, the larger the enterprise the more detailed must be the subdivision of expense items, and the greater must be the care exercised in laying out a system of expense accounts which shall culminate in one concise, accurate account, portraying the changes in this important factor of costs.

10. *Special reports.*—A well-kept cost system is a mine of information for the thoughtful manager. In addition to the benefit from regular reports, such as have just been discussed, he may find much assistance in special reports. Thus, in case the cost record shows that money has been lost on a contract, the cost keeper should be able to furnish a detailed statement of all labor and material that has gone into the work. Such a statement is invaluable in regard to both finding out what is wrong and proceeding to remedy the difficulty. Until a manager has made a study of the cost of producing a given part, by means of such a special cost report, in company with his designer, toolmaker,

manufacturing superintendent and others concerned, he will not fully appreciate the full value of accurate costs.

There are many other reports that are based more or less on the cost records as, for instance, the progress report, which gives a statement of the condition of all orders in process of production. But enough has been said to illustrate the statistical value of these records, aside from the problem of finding particular costs.

11. *Form of reports.* The form in which statistical data are presented is of great importance. The form that is satisfactory in one place may be entirely inadequate in another; and the copying of blank forms from one system to another should be done with caution. There are a few underlying principles, however, which, if well understood, will enable any intelligent cost keeper to originate suitable report blanks. Some of these principles will now be briefly discussed.

All statistical data gain in value if presented in such a manner that contrasts and comparisons may be drawn. Thus in Figure 24 (page 280), the costs are so presented that the maximum, minimum and average costs of a large number of pieces of one kind can be computed easily and quickly. In Figure 26 (page 297), a comparison between the data for the given month and the average for the period since the first of the year, is made with ease.

This method of contrasting results of a given period with those of some other period is quite common. Ex-

pense records are usually compiled in this manner, the idea being that any change in values will be more quickly noted, and inquired into if necessary. The weakness in this method is that it is based on the assumption that other factors remain constant, which may or may not be true. This is well illustrated in Figure 26, page 297, which represents a typical report, where the items for the period considered are compared with the average of such periods since the beginning of the year. While such comparisons are useful and may suffice for some purposes, they are not sufficient for others where the standards of measurement must be more definite.

Thus, it may be important to know the value of the output of the factory for a given period as compared with some other period, but it is more valuable to know the output per unit of capital invested, or per employe at work. The total amount of coal burned in the power plant for the month, as compared to other months, is worth knowing; but the cost of the coal burned per horsepower hour is a much more intelligent check on the efficiency of the power station. The cost of a given article is an important matter, but its comparative cost judged by other performances may be much more important. It will be noted that this form of comparison is very different from the first method discussed. In the first method, comparison is made between performances; while in the latter, the comparison is made between the performances and a standard of some kind.

12. *Standards.*—This principle of standards for comparison should be carefully noted. If standards of performance can be established, cost data can be interpreted with a great degree of accuracy and intelligence. This is illustrated in the case of the power plant just referred to. The amount of coal per horsepower hour that should be consumed under normal conditions in a given power house, can be determined with fair accuracy, and any departure therefrom should be explainable on the analysis sheet, and without regard to past or future performances. If, again, it is known what the ratio of direct labor to indirect labor should be, the manager has a standard whereby he can judge the indirect labor much more accurately than he can by comparing the results of several periods where conditions may be widely different.

The whole tendency in modern manufacturing and industrial enterprises is to find standards of performance which can be used not only as a criterion after completion, but also as a means of predicting performance before it is started. Viewed from this standpoint, the importance of cost finding is self-evident, and its value to the manager increases as competition becomes keener.

13. *Graphic reports.*—The comparison of statistical results with one another, and with a common standard, is greatly facilitated by graphic methods which show the history of any item under examination. These methods also make it much easier to compare different sets of data, and indicate tendencies much

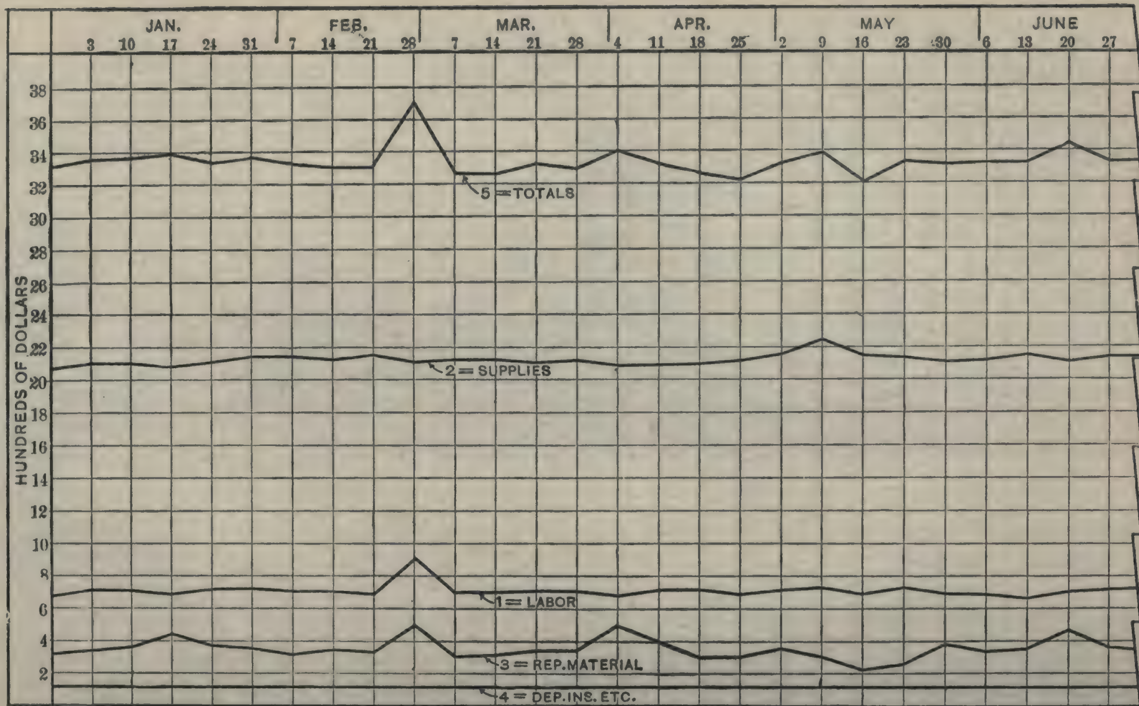

FIGURE 27—GRAPHIC RECORD OF POWER-HOUSE EXPENSE

more clearly than tabulated statements, which are always difficult to summarize visually. Figure 27, opposite, shows, graphically, the history of a set of costs incurred in operating a power house, similar to those listed in Figure 26 (p. 297). The tendencies of such accounts can by this method be checked much more readily than when the same values are expressed in tabulated figures. In the illustration, a sudden rise is shown on the curve of totals about February 28th. The origin of this rise is easily traceable in curves 1 and 3, and evidently, is due to some repair work. The graphic method is of very wide application and is very useful in all cases where a large number of figures are to be assembled in tangible form.

14. *Making use of reports.*—It will be noted that it costs money to compile reports and for that reason great care should be used in selecting the reports that are considered necessary for managerial control. Unless the reports are of some use, and unless they tell something of value which bears on the cost of production or the conduct of the business, they are a source of wasted money and should be discontinued.

Conversely, if a report is useful it should be used to its full worth. Unless a good report serves as a basis of an analysis of results, or as the basis of a discussion which throws light on some aspect of the business, it represents time and money wasted. Reports are tools, suited or unsuited to their work, the degree of whose usefulness depends upon how intelligently they are used.

15. *Committees.*—Perhaps the best method of making use of a report is to have it discussed by a committee of those interested in, and competent to discuss the data it presents. Such committees and committee systems have an important bearing on costs which may be considered.

It may be well, in this connection, to note the basic reason for the usefulness of committees. Industrial work, and for that matter life itself, has become so complex that division of labor has been necessarily carried to an amazing degree. In an industrial enterprise of any size, each man's field is closely circumscribed, and he may have little opportunity of becoming familiar with what his neighbor is doing tho the two men may be engaged in closely related work.

Industrial problems, however, are usually complex, and no one man may be competent to solve them. It is necessary, therefore, to call together those representing the several functions that were once exercised by one man and decide the question under consideration after it has been viewed from all angles. An illustration may make this point clearer. Suppose, a case arises when it is imperative that the cost of a given article be reduced; and suppose, further, that the cost department has presented to the factory manager a special cost report showing in detail the labor, material and expense expended upon the article in question. It will be assumed also that the article is made in quantity and involves the use of special tools

and fixtures. The questions involved, therefore, have to do with the theoretical design of the article, the design and use of tools, the number of articles to be made at one time, and the efficiency of shop processes. The men most naturally fitted to serve on a committee to discuss these points are, the engineer in charge of this line of work; the tool designer; the tool maker, and the shop foreman and other shop men who are familiar with the processes of fabrication involved.

16. *Value and limitations of committees.*—Each and every problem can be discussed by a committee intelligently. A change in the design may greatly simplify the special tools. A suggestion from the shop man may greatly reduce the labor cost. Difficulties in fabrication may be removed by slight changes in forms, and in countless ways the discussion will bring out methods of reducing costs and improving the product to a degree quite beyond the power of any one man. No one can appreciate the possibilities of a committee till he has had experience with one committee of the kind that has just been suggested.

Obviously, the number and character of the committees necessary will depend on the nature of the industry and the size of the enterprise. The committee method, like almost any other system, has limitations that must be observed. It would be out of place to have a large number of committees in a small shop and such procedure would probably result in financial loss. But in any enterprise large enough to have a cost sys-

tem and executive cost reports, careful consideration should be given to the committee idea, if best results are to be obtained from these reports.

REVIEW

What do you consider the principal value of a labor report? Could you sketch out the form of labor report mentioned in this chapter?

What methods should be employed in interpreting reports of labor, material and expense?

How would you prepare a form of expense-analysis sheet for a shipping and transportation department?

If you were employed to take charge of a statistical department of a manufacturing business, what general principles would you employ in preparing your reports? What reports would you provide for?

What is the chief advantage of standards of performance?

Do you approve of the committee system described in the Text?

To what extent would you adopt the plan in your own business?

CHAPTER XIX

PREDETERMINATION OF COSTS—MATERIALS AND LABOR

1. *General.*—The functions of a cost system as a means of finding and recording costs, and also as a basis of managerial reports, have been discussed in the preceding sections. It remains to consider the third, and in some respects the most important, use of a cost system, namely, the predetermination and control of costs. It has been shown (see Section 15, Chapter XVIII) how the cost of an article already produced may, perhaps, be reduced after studying the cost records; and it will be clear that, in general, accurate costs are a powerful means of studying cost reduction. If the costs show a certain record of performance, there would seem to be no reason why this performance cannot be repeated. Experience shows, however, that such is not always the case; in fact, it is a rare thing to have two lots of product come out at the same cost, even tho produced on the same machines and by the same men, unless special care is taken to insure this result (see Figure 24, page 280).

Yet the ability to predict performance and costs becomes more important daily as competition becomes more keen and strenuous. A few years ago it was

not uncommon practice in the case of construction jobs, to trust to the honor and ability of a contractor, and to reward him by paying him a percentage on costs. This form of contracting still survives to a limited extent tho, generally, the contractor is called upon to state a definite maximum price. In most cases, however, the contractors, builders or merchants who are supplying goods are required to bid on the contract, the lowest bidder securing the work. From the grocer who sells a pound of sugar, to the man who bids on the construction of a canal or a battleship, a guarantee of maximum price is usually demanded before any business is transacted; and the bargain is not infrequently cemented by legal agreements and bonds, or other financial guarantees of faithful performance.

2. *Difficulties in predicting performance.*—When the contractor or merchant turns his eye inward on his enterprise, with a view to computing the price at which he can compete, he is, in general, confronted with the difficulties that have been discussed in the preceding chapters; and he must, in most cases, use extreme care in answering the momentous question—What is the cost of production? Material values he can usually compute with fair accuracy, but the case of labor is different. He finds that, in general, the *price* of labor per diem is fairly definitely fixed; but he may find no relation between that price and the *output* per diem, and the vexing problem of expense is ever with him. If the work is similar to some he has already done, good cost records will give him an adequate idea

of his limitations, *provided he can insure a repetition of the performance.* If the work is new in character, his costs may still be of great value, tho not based on this new class of work. The wide variation in almost any set of bids, even where the article is closely specified, is sufficient evidence of the difficulties that are to be met in predicting costs of production. For these reasons, and for others, which have been discussed in the foregoing chapters, there is a rapidly growing demand on the part of managers for more accurate methods of cost prediction than are generally available.

3. *Estimating costs of production.*—Costs of production may be estimated for one of two purposes—namely, as a basis for bidding on work in the open market, or for fixing the price of production in the factory in advance of actual work. Estimating for the first purpose may here be considered, so far as cost finding bears upon this problem.

Estimating, of any kind, without the use of cost data can be little more than skilful guessing; unfortunately, much of the estimating that is done is of this character. Where large margins of safety can be had in the way of good profits, these simple methods may suffice; but wherever competition is a factor, successful bidding must rest on cost data of some kind. In many callings and industries, considerable data of this kind have been compiled, and may be found in books on estimating. It should be noted, however, that such data must be considered as representing

average results only; a keen estimator will not be satisfied with accuracy of his predictions until he possesses data representing the best practice of his own enterprise. In general, therefore, each enterprise must collect its own data in accordance with the principles of cost finding which have been discussed in the preceding chapters.

These remarks hold true with even greater force in regard to the predetermination of costs for the purpose of setting labor values in the factory in advance of production. Without accurate cost data, it will be found that piece prices, or in fact any other form of prediction of labor values, are little better than guesses. Furthermore, unless these cost data have been obtained under standardized conditions, and unless they represent not only *what has been done* but, approximately at least, *the best that can be done,* the estimator cannot be sure that he has obtained accurate results.

4. *Distinction between actual costs and estimated costs.*—A careful distinction should be made, therefore, between predicted costs based on actual results, and certain other kinds of estimated costs. Cost estimates made in advance may be successfully realized in actual productive performances; but it should be remembered that actual costs must always be based on actual performance, and before estimated costs are used in any way, they should be carefully compared with actual results. Some of the cost systems in com-

mon use, based on estimates only, and unchecked by actual records of results, must be considered, at best, entirely inadequate.

Thus, it is often customary to make an estimate of cost based upon estimated values of material, labor and expense, the estimates, for the most part, being based upon empirical information and personal judgment. If the productive operations involved are repeated, this estimate is checked or tested, in a rough way, and such corrections as may appear necessary are made, this procedure being repeated as often as may seem desirable. Clearly, such rough rule-of-thumb methods of predicting costs cannot be considered seriously when compared with methods based on any of the cost systems that have been discussed; yet the amount of estimating made in this manner is surprising.

Similar considerations apply to methods such as the list-percentage plan, so-called, that is sometimes used in continuous-process industries with products such as soap, brick, and cloth. Under this method, the costs of production of each brand or line of products are estimated by a percentage based upon the list prices. These list prices may not be the actual selling prices, but they will be proportional to them. The estimated costs are then checked by actual experience, and corrections are made where necessary. There may be instances where such crude methods will suffice, but it would seem that, if these estimated costs could be checked with accuracy by actual performance, it would

be easier and more logical to accumulate accurate cost data on which more rational estimates could be made in the first place.

5. *Predetermination of material costs.*—The predetermination of material costs usually offers little difficulty. The art of designing all manner of manufactured product in advance of production, and of specifying the characteristics of material needed for the work, has been so highly developed that little need be left to chance, so far as direct material is concerned. Material can be weighed, counted, or otherwise measured in such a way as to make it possible to issue just what is needed to satisfy the requisitions (see Sections 4 and 5, Chapter VII); and the fixing of the material values in advance of production, so far, at least, as direct material is concerned, can be made with some assurance of realizing the expectation. Losses due to waste and mistakes are unavoidable but, as has been explained (see Section 16, Chapter VII), these can be minimized, with proper care. The problem of predicting expense material is, of course, a part of the problem of predicting expense, or burden.

Obviously, also, if the material lists made for a given article are accurate, they need not be changed, so long as the article is made in that particular form. Such lists, therefore, become standard and may serve as a definite basis of calculating material costs in advance.

6. *Control of labor costs, day rate.*—The control of labor costs is an entirely different matter, especially

where the workers are on day rate. Even in the case of conscientious workmen there is a wide variation in the cost of production of similar articles at different periods. This is often due as much to varying conditions of production as to any remissness on the part of the workers; but even with the best of workmen the rate of production will vary greatly where the day rate is assured and where, consequently, there is no special incentive for men to do their best. This is very well illustrated in Figure 24 (page 280), which shows a record of actual production in a well-managed shop. The variation in the productive time of various men and at different times is here clearly shown; and the difference in total cost per piece, shown in the last column, is not unusual. Evidently, the prediction of costs, under such circumstances, must be based on an average of experience, or else a large allowance must be made for possible variation.

7. *Control of labor costs, piece rate.*—These considerations, no doubt, have had great influence in extending piece-rate methods. If the employer can persuade the workman to do a given piece of work at a definite labor price, the labor cost becomes definite and stable, and will remain so as long as the agreement holds good. The defects and difficulties of straight piecework methods have been touched upon in Section 5, Chapter VIII, to which reference should be made at this point. These disadvantages are real, and it is apparent that piecework is not universally applicable. There are many lines of manufacture,

however, where this method in some form must be used, for best results. Thus, in product consisting of many small parts, and in the manufacture of which the competition is keen, piece rates in some form are essential to stable costs that can be used with assurance in predicting future performances.

It would appear, at first sight, that there is less probability of such variation in piece-rate costs as appear in Figure 24, page 280, which is based on day rate. If, however, different piece rates for the same piece of work are given to different operators, variations as wide as these may appear. They often occur where high-priced operators are put to work, in an emergency, on a class of work that is ordinarily performed by lower-priced men, for the higher-priced men insist upon and obtain a special higher rate.

8. *Labor-cost control under advanced wage systems.*—A careful consideration of the more advanced wage systems described in Sections 7 to 10, Chapter VIII, will show that these systems recognize the general principles just discussed. All of them, except the Taylor differential piece rate, recognize the value of the day rate as a basis of labor reward, but all of them lay stress, also, on the accomplishment of a definite amount of work before extra reward, or bonus, is given. This definite amount is also the minimum amount of output which, in the opinion of the employer, the workman should produce, tho, if he produces more, he is rewarded accordingly. All of these advanced methods of labor reward, therefore, aim to

secure a definite amount of product for a definite amount of pay, and hence embody an essential principle of piecework.

If the workman produces just the minimum amount of work required of him, but does not earn a bonus, the cost per piece is the lowest that the employer can obtain under these systems of pay. If the worker exceeds this minimum and earns a bonus, the cost per piece rises; but this rise in price is, presumably, more than offset by the decrease in burden due to increased output. Obviously, however, if the minimum is so set that the worker can greatly exceed it and thus earn large bonuses, the labor cost may vary almost as widely as under day pay. This criticism is sometimes made of the Halsey premium plan, since under it the required minimum output is based on day-rate records, which may or may not show what a fair day's work should be.

The criticism of cost records based on daywork, piecework and the Halsey premium plan, made by advocates of more advanced methods is, that while these records show *what has been done,* they fail utterly to show *what can be done.* In their efforts to establish a more stable relation between labor reward and labor cost, these advocates have introduced methods that promise to have an influence on costs that will entitle them to special consideration. Only brief mention can be made here of these methods, and only such discussion of them will be given as pertains to costs and cost finding.

9. *Time-study.*—It has long been a practice among progressive managers to try to control labor costs by making preliminary studies of the time required to perform operations. Sometimes this is done by having skilled workmen, who are in the confidence of the employer, make preliminary trials of the job; in some cases this work has been done openly, either in the production department proper, or in special shop laboratories equipped for the purpose. It remained for Mr. F. W. Taylor to systematize and refine methods of observation, with a view to the general solution of the problem of determining how long a given piece of work should take.[1]

Under these more refined methods, the time required to perform each detail of a given operation is taken with a stop-watch, by trained observers, and carefully recorded. Observations are made of many repetitions of each detail operation, as performed by several competent operators, and the recorded "unit times" are used as a basis for establishing a *standard of performance* from which other similar performances may be predicted, either in whole or in part. Allowance must be made, of course, for fatigue and rest and many data are already available on this point.

It will appear at once that there are limitations to this method, particularly when the number of pieces to be produced is small, but it is obvious that as a mode

[1] Those who wish to study these methods in detail are referred to Mr. Taylor's monumental paper, "Shop Management," in the "Transactions of the American Society of Mechanical Engineers," Vol. 24.

of approaching labor-cost control it is a great advance over old empirical methods. Without doubt, time-study is destined to occupy a prominent place in industrial management, where refined costs are a factor.

10. *Motion-study.*—It has long been recognized that the amount of work produced by a workman is greatly affected by the *convenience* of his surroundings and tools. Complex assembling operations are usually made the object of careful study so that everything may be conveniently arranged and, furthermore, so that the *sequence* of operations may be the most effective. For the most part, however, these attempts have been confined to the best examples of mass production. The work of Mr. Frank Gilbreth has called attention to the fact that great gains in production can be made by systematic *motion-study* in all lines of work. The most interesting feature of this idea is that it frankly questions the efficiency of the methods practised even by the simpler trades, and it has been conclusively shown that the handicraft practices are often far from efficient. It has been proved that many unnecessary motions can be eliminated even in cases where it was supposed that the highest efficiency had already been reached; the result is a gain in production and a lessening of the fatigue.

Motion-study, therefore, in conjunction with time-study, makes it possible to predict with reasonable accuracy how a piece of work should be done, and how long it should normally take to do it. The limitations of motion study are important, however, and

should be carefully studied before these methods are applied. The human factor involved in the application of these methods is of the utmost importance and it should be carefully considered.

11. *Industrial data.*—The ability to predict costs will depend not only upon the information gathered by time-study and motion-study but also considerably upon the exact knowledge of industrial processes that the rate-setter possesses. Thus, in machine work it may be possible to predict how long it should take to set a piece of work in the machine and get the work started. The time it may take to do the given machine operation will depend, however, on the capacity of the machine and the efficiency of the cutting tool. Data of this kind are not available in most industries and must, in general, be obtained for the specific work in hand. The task of collecting these data may be difficult even in what may appear to be simple operations, as shown in Mr. F. W. Taylor's experimental work on the art of cutting metals where twelve variable factors were found. It should be carefully noted that the skilled workman cannot usually give an accurate statement of the most efficient means of accomplishing his task. This is because of the complexity of even simple industrial processes, and because most workmen do their work as they were taught by older men to do it, with little or no thought, often, as to really efficient methods. Some progress is being made in collecting industrial data in many lines of work and in the near future, no doubt, the information

gained from such data will prove of the greatest benefit in the solution of difficult industrial problems.

12. *Standard performances.*—If, then, the manager possesses information such as has been described in the three preceding sections, he will be able to predict with some degree of certainty the best way of doing work, and the time it should take to do it. Figure 28 (page 320) illustrates an instruction card, so-called, showing a case where this has been done. It will be noted that the sequence of the several operations is prescribed; the number of the proper tool is given, where necessary; and the depth of the cut, the feed, and the speed at which the tool is to be driven are also stated. The time that each operation should take is given, and also the total time for the lot, including the time for changing the machine for another job. An allowance of ten per cent is made, as a margin of safety. The total predicted time is recorded in such a way that it can be compared with the time actually required, which is also noted on the card.

If an instruction card, illustrated in Figure 28, is to be taken as a standard of performance, every surrounding condition must be carefully standardized, or else it will be impossible to realize the prediction in actual practice. The problems of standardizing industrial processes lie outside the limits of this book; for a fuller discussion of modern planning methods, the reader is referred to the Modern Business Text on "Factory and Office Administration."

13. *Limitations and difficulties.*—Evidently, there

STANDARD MFG. CO. NO. 275

INSTRUCTION CARD

ORDER NO.	DRAWING NO.	PART NO.	NO. OF PIECES	MATERIAL	MO.	DAY	YEAR
0456	241	3B	30	CI	7	24	1916

WORKMAN'S NAME	MACHINE	SPEED BOSS
Wm Brown	Lathe 65	Thomas Jones

	INSTRUCTIONS	TOOL	CUT	FEED	SPEED	PIECE TIME		LOT TIME	
1	Preparation							10	00
2	Chucking and centering							15	00
3	Rough face	F4	.15"	.06"	P4	8	00		
4	Change feed and Speed						06		
5	Rough Bore, 2 Cuts	B3	.09	.08	G6	20	00		
6	Finish Bore	B4	.02	.10	G5	8	00		
7	Change Feed and Speed						06		
8	Finish Face	F6	.02	.15	M2	6	00		
9	Stop Machine and								
10	Take out Work						25		
11	Clean machine and								
12	change Work Order							2	00
13									
14	Add 10% to Piece Time						43		
15									
16									
17									
18									
TOTALS FOR ONE PIECE						42	80	27	00

TOTAL TIME FOR 30 PIECES = 42.8 x 30 x 30 + 27 = 155.40

TOTAL TIME ACTUALLY TAKEN 150.00

WHEN MACHINE CANNOT BE RUN AS SPECIFIED REPORT AT ONCE TO

R. S. Thomas

SIGNATURE OF SPEED BOSS

Thomas Jones

FIGURE 28—INSTRUCTION CARD

will be limitations to the refined methods of cost prediction just discussed. They cannot, for instance, be economically applied where the product is small in volume and of great variety. In fact, the same limitations that have already been noted regarding elaborate cost-finding methods apply to the planning of costs in advance or to the prearranging of any other part of administration where system is needed. There are limitations and difficulties also in operating these methods from the standpoint of the human element involved.

How far it may be economically possible to introduce these methods that have been so widely discussed in connection with scientific management, as this movement has been called, cannot be discussed here. The general idea of predicting labor values will, however, become a permanent feature of industrial management, and progressive managers should give this phase of cost finding careful attention, especially where the volume of production is large, and competition keen.

14. *Connection with advanced wage systems.*—The reasons for some features of the advanced wage systems discussed in Chapter VIII will now be clear. These new methods of rewarding labor have grown out of the effort to set a definite task for the worker. Thus the Gantt bonus method, which may be taken as typical, sets a definite task which must be accomplished before a bonus, or extra reward, is given. For any production less than the task, only day rate

is given. The object of this bonus is evident. The task, set on the basis of time-study and the standardization of all surrounding conditions, is large, and the worker can generally accomplish it only by carefully following directions and detail instructions. The only incentive that will induce him to make this added effort is added compensation. If the preliminary studies are accurate, it will appear that the task can be so set as to demand the workman's utmost effort, and it is this aspect of these new methods that has received the strongest condemnation. Aside, however, from the possibility or advisability of installing such wage systems, the influence of these methods on cost prediction should be carefully noted. All ways and means that enable the manager to control labor costs, or to remove in any way the uncertainty that usually surrounds the cost of production, will be carefully studied in the near future.

REVIEW

What distinction do you make between estimated costs and actual costs?

What are predetermined costs, and how are they obtained?

What are the principal difficulties encountered in predicting performance?

How are labor costs controlled under the different systems of wage payment?

How would you undertake time- and motion-studies?

What are the essential features of an instruction card?

CHAPTER XX

PREDETERMINATION OF COSTS—EXPENSE

1. *Preparation costs.*—All work is divisible into two stages, namely, preparation and actual operation. Thus, it will be noted that in Figure 28 (page 320), the time for preparation, and the time for changing the machine at the end of the operation, are planned as separate items. The importance of the time required to get ready to do a piece of work is often overlooked, in spite of the fact that it may have a great effect upon the cost per piece; no one thing shows more clearly the desirability of making parts in quantities.

Referring to Figure 29 (page 324), suppose that it takes four hours to prepare for a piece of work. This constant value, no matter how many pieces are made, is indicated by the vertical ordinates of the line AB. Suppose, further, that it takes one hour to do the operation on each piece, after preparation has been made. Then the number of hours consumed in actual operation on any given number of pieces is indicated by the vertical ordinates between the line AB and the line AC; and the total time required to prepare for, and produce, any given number of pieces will be indicated by the ordinates between OM and AC. Thus,

it will require fifty-four hours to prepare for and produce fifty pieces; twenty-nine hours to prepare for and produce twenty-five pieces, and so on.

The unit time, or time per piece, is found by divid-

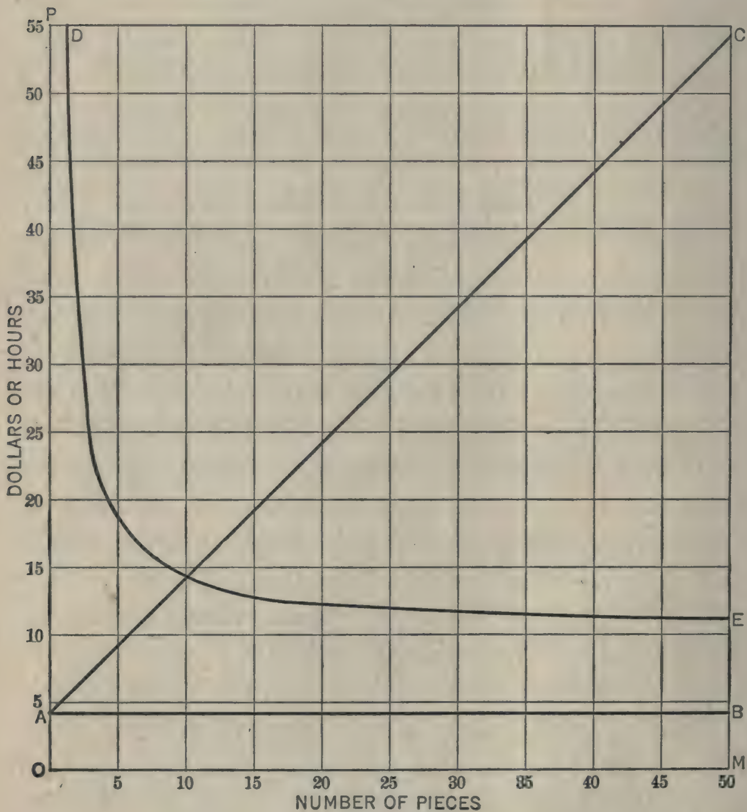

FIGURE 29

ing this total time, or the sum of the time for preparation and the time of operation, by the number produced. For one piece, then, the unit time is 4 + 1 ÷

$1 = 5$ hours; for two pieces, it is $2 + 4 \div 2 = 3$ hours; for five pieces, it is $4 + 5 \div 5 = 1.8$ hours; and for fifty pieces, it is $4 + 50 \div 50 = 1.08$ hours. The curve DE is the curve of unit times, its vertical ordinates being one-tenth the value of those used for AC. The rapid fall on the first part of this curve should be carefully noted. The greatest fall in unit values occurs when two pieces are made instead of one, a constantly decreasing gain per piece being obtained as the number increases, till, after thirty or forty pieces, the preparation time becomes almost negligible, so far as the unit cost is concerned. This principle, which holds good whether the preparation is measured in time or dollars, is, in fact, the basic principle of mass production; and the larger the number that are to be made, the more the time and money that can be economically expended on preparation and planning of all kinds. Data bearing on preparation are therefore very important in cost prediction.

2. *Application to special tools.*—The general principle discussed in the preceding section applies also to all special tools, such as jigs, fixtures, etc., and, in fact, to all preparatory work such as making drawings and patterns, that may be chargeable to any particular piece of work. Suppose, for instance, that the manufacturing expense is equal to the direct labor, and that the labor cost on a given piece of work is two dollars. Then the cost of production (aside from the material values) will be four dollars. Suppose, further, that by making a special tool worth $60 the labor cost can

be reduced to fifty cents, and the productive cost, not including cost of material, is consequently reduced to one dollar. Since the gain in productive cost is three dollars per piece, twenty pieces must be made before the tool will be paid for. The unit cost when just twenty pieces are made, will be $\frac{60 + 20}{20} = \$4$, or the same as when no special tool is used. If more than twenty pieces are made, the unit cost will be decreased; and if less than twenty pieces are produced the unit cost will be more than $4, and the special tool will be the cause of a loss. Thus, if 100 pieces are made, the unit cost will be $\frac{60 + 100}{100} = \$1.60$; while if only four pieces are made, the unit cost will be $\frac{60 + 4}{4} = \$16$.

If sixty pieces are made, the cost of the tool equals the cost of the labor and the expense. Up to this number of pieces, the controlling factor in the unit cost is the cost of the tool; but beyond this number, the controlling factor is the labor cost, and the cost of the tool soon becomes a small part of the unit cost. Thus, it has been shown that when 100 pieces are made, only 60 cents is added to cover the cost of the tool. Intelligent cost prediction, where the use of labor-saving tools is involved, must take account of these factors. It has already been shown that in the case of all equipment the interest on the investment must also be taken into account.

3. *Graphic cost data.*—The values shown in Figure 29 (page 324), have been assumed at random, but they are probable values. The usefulness of expressing standardized cost data in this form will be evident when costs are to be predicted. If laid off on sheets of large size such graphs will save much computation where varying numbers of pieces are to be produced from time to time; they will also serve to indicate quickly the minimum number of pieces that can be economically produced.

The principle involved is also of very great importance to the small manufacturer who is making parts which require considerable preparation. The decided saving in unit cost that follows from making even a small number of parts at one time, where preparation is a factor, is not, in general, well understood; yet careful planning in advance would often make such savings possible.

4. *Control of expense.*—It will appear from the discussion in Chapter X that the methods of cost control and cost prediction, as applied to material and labor values, as previously discussed, are not applicable to expense, or burden. It is not possible, under any known system, to predetermine with accuracy each item of expense material and labor that will be needed for a given piece of production, since, as has been explained, many of these items are not directly connected with the given piece; in fact the connection may be very remote.

The totals of these expenditures can, however, be

closely controlled by properly arranged cost reports, as has been explained in Chapter XVIII. A very effective way of doing this is to set limits to the amount that each foreman may spend, in a given period of time, for each class of expense. Weekly or monthly statements should be issued from the cost department, in order that the attention of each official may be periodically called to the important question of how his budget stands. Much of the excess and variation in expense outlay is due to wastefulness, and it is surprising how quickly and effectively a budget system of this kind will remedy some of these wastes. Care should of course be taken that the budget is made up on correct data so that the work of production may not suffer. There is no economy in reducing the amount of oil to the point where bearings will suffer, or in reducing the amount of waste to be used to the point where machines will be untidy. In general, however, a budget system will reveal an excessive use of expense material and labor, and will decidedly tend to check wastes and keep constant the relation between direct production and expense.

Since all the methods of distributing expense establish a relation between expense and some feature of material or labor, a close approximation of the expense necessary for a given piece of production can usually be made when this basic factor is known. This relation can be used with some assurance if expense totals are controlled in such a way as has been indicated. But this approximation cannot be compared in ac-

curacy with those methods of predetermining labor values that have been treated up to this point.

5. *Conclusions.*—The treatment of the subject up to this point will have made it clear that no one method of cost finding can be laid down that will answer the requirements of every situation. Each case must be studied independently and a system selected that will be applicable to the problem at hand. The discussion in the previous chapters is based, for the most part, on the problem of cost finding in manufacturing plants, for the reason that it is in these plants that the problem is most complex and most perplexing. The general principles discussed hold true, however, for all cost-finding methods, tho the exact manner of their application necessarily differs with circumstances.

It is of prime importance, therefore, that the executive, in installing a cost-finding system, or in operating one already installed, should have a clear idea of just what results are desirable. A cost-finding system should be planned in advance as much as, if not more than, any other part of the factory system. It should obtain just the results wished, and it should not gather a lot of useless data. Such a system can fail because of too much detail, as easily as it can fail because of lack of results. It is of importance, also, that the results obtained be made use of, for cost data which are not used represent wasted money. It requires a man with knowledge, intelligence and judgment, well informed in the details of the business, to plan and oper-

ate successfully a cost-finding system, if the problem is at all complex.

The introduction of a cost-finding system is often difficult. This is true partly because the human element enters largely into the success or failure of nearly all so-called "systems." Workmen are not generally interested in cost-finding methods, foremen are often antagonistic, and even the superintendent may be at least apathetic. It often takes considerable time and persistence to put a cost-finding system into successful operation; and it nearly always requires the firm support of the managing executive to maintain it. When, however, the executive has once developed a cost-finding system which presents to him the complete costs of his units of production; which shows him in intelligent detail where the money has gone, whether for direct or indirect production; which shows him the relative values of different methods; and which enables him to check inefficiency in machine, process or employe—when the executive has perfected such a system, he has obtained the best possible safeguard against failure, and a guide to future operations which must be used to be appreciated. The need of a cost-finding system of some sort is so basic that it is marvelous indeed that any man should think of operating a factory without one; and, without doubt, wherever competition is a factor, a cost-finding system will be the corner-stone of the factory of the future.

REVIEWS

What are preparation costs?

Of what advantage is the graphic method for the presentation of cost data?

What general conclusions are the result of your study of this volume? Why do many cost systems fail?

What difficulties are usually experienced in introducing a cost system? How would you plan to overcome them?

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THE END